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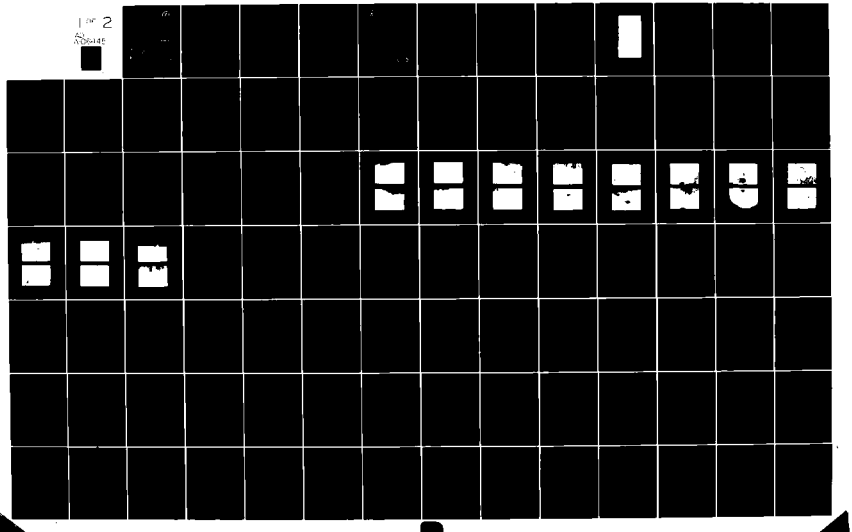

LEVEL II

(1)

MISSOURI-KANSAS CITY BASIN

AD A106445

UNION LAKE DAM

JACKSON COUNTY, MISSOURI

MO 30225

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

DECEMBER 1980

UNCLASSIFIED

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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MISSOURI-KANSAS CITY BASIN

UNION LAKE DAM

JACKSON COUNTY, MISSOURI

MO 30225

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
Serving the Army
Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

DECEMBER 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Union Lake Dam, Mo. ID No. 30225
Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Union Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 02 APR 1981 — Date

APPROVED BY : SIGNED — Colonel, CE, District Engineer — 03 APR 1981 — Date

UNION LAKE DAM

JACKSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30225

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

DECEMBER 1980

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Union Lake Dam
State Located	Missouri
County Located	Jackson County
Stream	Tributary of Blue River
Date of Inspection	4 December 1980

Union Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately two miles downstream of the dam. Within the estimated damage zone are more than five dwellings, three roads, Interstate Hwy I-435, a railroad yard, and miscellaneous industrial facilities. Contents of the estimated downstream damage zone were verified by the inspection team.

Our inspection and evaluation indicates the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillways will not pass the probable maximum flood without overtopping but will pass 10 percent of the probable maximum flood. The spillways will not pass the flood which has a one percent chance of occurrence in any given year (100-year flood); but will pass the flood with a 10 percent chance of occurrence (10-year flood). The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the damage zone, the spillway design flood should be 100 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in less than satisfactory condition. Deficiencies visually observed by the inspection

team were dense tree and brush cover, extremely steep upstream and downstream slopes, erosion of the upstream slope at the waterline due to wave action, erosion of the downstream slope from surface runoff and/or overtopping, partially plugged flow conduit, disjointed and displaced primary spillway pipe sections, a small sink hole over the primary spillway pipe, spillway channel erosion, and small animal burrows in the embankment. Seepage and stability analyses required by the guidelines were not available.

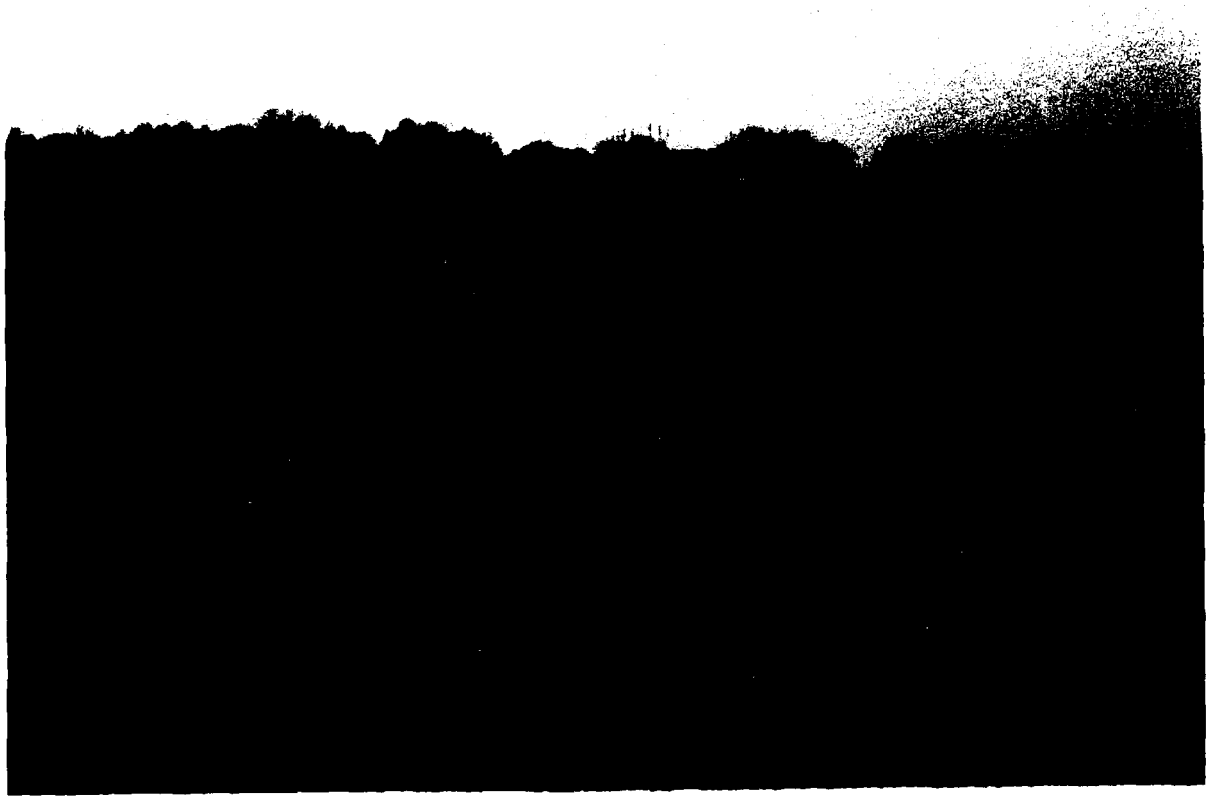
There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

Edwin R. Burton

Edwin R. Burton, PE
Missouri E-10137

Harry L. Callahan

Harry L. Callahan, Partner
Black & Veatch



OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
UNION LAKE DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Union Lake Dam, formerly called Joe's Fishing Lake, be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary of the Blue River (see Plate 1). The watershed is an area of low hills with fairly steep terrain consisting of about 60 percent urban development, 30 percent timber and 10 percent grassland. Small single family houses are located on large lots on the periphery of the watershed. Immediately upstream of Union Lake's reservoir pool is a small earthen dam and pool. The Union Lake dam is approximately 305 feet long along the crest and 27 feet high. The dam crest is 10 feet wide and is on a curved alinement. The downstream face of the dam has a nonuniform slope from the crest to the valley floor below.

(2) The spillway facilities for this dam consists of three conduits of different diameters. The primary conduit is a 30-inch concrete pipe located near the left abutment which discharges to an eroded channel. The inlet of this spillway includes a 22.6 feet long, 5.3 feet high concrete headwall.

Located near the right abutment are two conduits which also serve as points of discharge for this reservoir. One, a 12-inch diameter concrete pipe is partially plugged with earth, and the second is a 16-inch diameter corrugated metal pipe. Both pipes discharge to an eroded

channel on the right abutment. There is no headwall for these pipes, but there is a small trash screen a short distance upstream from these inlets.

(3) Located immediately upstream of Union Lake is a small earth dam. This dam has an 18-inch diameter corrugated metal pipe conduit spillway located near the right abutment. The dam has a worn gravel road across its crest.

(4) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in northeast Jackson County, Kansas City, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Independence, Missouri in Section 17 of T49N, R32W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the small size category. A small size dam is classified as having a height less than 40 feet, but greater than or equal to 25 feet and/or a storage capacity less than 1,000 acre-feet, but greater than or equal to 50 acre-feet.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Union Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Union Lake Dam the estimated flood damage zone extends approximately two miles downstream of the dam. Within the estimated damage zone are more than five dwellings, three roads, Interstate Hwy I-435, a railroad yard, and miscellaneous industrial facilities. Contents of the estimated downstream damage zone were verified by the inspection team.

e. Ownership. The dam is owned by the Sheet Metal Workers Local No. 2 (contact Mr. Foster), 101 E. Armour, Kansas City, Missouri 64111.

f. Purpose of Dam. The dam forms a 4.0-acre lake used for recreation.

g. Design and Construction History. Data relating to the design and construction were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and flow through the uncontrolled conduit spillways all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 61 acres, 30 acres uncontrolled.

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through the three spillway conduits.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 53 cfs (Probable Maximum Flood Pool El. 913.4).

c. Elevation (Feet above m.s.l., adjusted from Kansas City, Mo. datum).

(1) Top of dam - 911.6 (see Plate 3)

(2) Primary spillway pipe inlet invert - 909.2

(3) Secondary spillway pipe inlet inverts - 909.5 - 16 inch, 910.4 - 12 inch

(4) Streambed at toe of dam - 884.3

(5) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 520 feet ± (Probable maximum flood pool level)

(2) Length of normal pool - 495 feet ± (Primary spillway crest)

e. Storage (Acre-feet).

(1) Top of dam - 40

(2) Primary spillway inlet - 30

(3) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 4.4

(2) Primary spillway inlet - 4.0

g. Dam.

(1) Type - Earth embankment

(2) Length - 305 feet

(3) Height - 27 feet ±

(4) Top width - 10 feet

(5) Side slopes - upstream face 1.0 V on 1.8 H, downstream face between 1.0 V on 2.0 H and 1.0 V on 3.3 H (see Plate 4)

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Primary Spillway.

(1) Type - Concrete pipe, 30-inch diameter.

(2) Inlet invert elevation - 909.2 feet m.s.l.

(3) Outlet invert elevation - 906.5 feet m.s.l.

(4) Gates - None.

(5) Upstream channel - None.

(6) Downstream channel - Discharges to an eroded channel leading to the natural stream below the dam.

j. Secondary Spillways.

A.
(1) Type - Concrete pipe, 12-inch diameter. (Blocked with earth)

(2) Inlet invert elevation - 910.4 feet m.s.l.

(3) Outlet invert elevation - 909.0 feet m.s.l.

(4) Gates - None.

(5) Upstream channel - None.

(6) Downstream channel - Discharges to an eroded channel leading to the natural stream below the dam.

B.

(1) Type - Corrugated metal pipe, 16-inch diameter.

(2) Inlet invert elevation - 909.5 feet m.s.l.

(3) Outlet invert elevation - 909.1 feet m.s.l.

(4) Gates - None.

(5) Upstream channel - None.

(6) Downstream channel - Discharges to an eroded channel leading to the natural stream below the dam.

k. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were not available.

2.2 CONSTRUCTION

Construction records were unavailable.

2.3 OPERATION

Operational records and documentation of past floods were unavailable. The watershed experienced a rainfall of about 12 inches in a 24-hour period in September 1977.

2.4 GEOLOGY

The dam is located across a shallow valley formed by a tributary to the Blue River. The soil of the dam and reservoir area consists of about 9 feet of low to medium plastic silty clay (CL for engineering purposes) developed in modified loess, overlying approximately 4 feet of highly plastic (CH for engineering purposes) residual clay underlain by the Chanute Shale. Bedrock of the general area consists of the Pennsylvanian age Kansas City Group. The formations consist of limestones and shales, with the Chanute Shale being the highest formation in the area, and the Block Limestone the lowest.

The foundation of the dam is on the Wea Shale with the Block Limestone present and outcropping in the middle dam area. The natural bottom of the lake is the Wea Shale with the Westerville Limestone cropping out along the shoreline. The left abutment consists of approximately 2 feet of low plastic silty clay (CL) over about 3 feet of highly plastic clay which overlies the Quivira Shale. The right abutment consists of the Quivira Shale.

2.5 EVALUATION

a. Availability. No engineering data were available.

b. Adequacy. No engineering data were available. Thus, an assessment of the design, construction, and operation could not be made. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Union Lake Dam was made on 4 December 1980. The inspection team consisted of Edwin Burton, team leader; Shannon Casey, geologist; Gary Van Riessen, geotechnical engineer; Paul MacRoberts, civil engineer; Thomas L. Rutherford, hydrologic/hydraulic engineer; and Anthony C. Davis, civil engineer. The dam is in less than satisfactory condition. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. Conditions visually observed by the inspection team included dense tree and brush cover, steep upstream and downstream slopes, erosion of the upstream slope at the waterline due to wave action, erosion of the downstream slope due to surface runoff and apparent overtopping, partially plugged outlet conduit, spillway channel erosion, disjointed and displaced sections of the 30-inch discharge pipe, a small sink hole located over the 30-inch pipe, and small animal burrows. No cracking, sliding, sloughing or other signs of instability or settlement were observed.

The dam crest has a narrow gravel road surface with worn spots caused by apparent overtopping and vehicle/foot traffic. The upstream slope has visible remnants of slope protection, eg. railroad tie retainer wall, and riprap. These deteriorated features might possibly offer some localized protection from wave action. The downstream slope is covered with brush and trees. Trees range in size up to about 10-inches in diameter.

An apparently nonbackfilled inspection pit was observed at the toe of the dam about 50 feet from the right abutment. Some fairly well defined erosion gullies were observed on the downstream slope starting near the dam's crest. Gullies have also been formed at the discharge end of the spillway pipes.

Both the downstream and upstream slopes contain debris, such as cans, and discarded household appliances. The upstream and downstream slopes of the embankment are extremely steep. No instruments to measure the performance of the dam were located. No toe drains or relief wells were observed.

There was no evidence that a maintenance program was in effect. A few animal burrows and mole tunnels were observed on the downstream slope.

c. Appurtenant Structures. The inspection team observed the following items pertaining to the appurtenant structures. The primary spillway is a 30-inch concrete pipe which discharges into a channel cut in the left abutment. There was evidence of erosion in the spillway channel downstream of the pipe. The spillway was considered to be in poor condition. Open and displaced joints observed in the primary spillway pipe are potential locations for internal erosion of the embankment to occur. This is a probable cause of an observed sink hole over the pipe (Photo 13). It should be noted that an abnormally large spillway discharge is likely to damage the embankment due to open joints in the pipes. The secondary spillways, 12-inch concrete pipe (blocked with dirt and debris) and 16-inch corrugated metal pipe located near the right abutment discharge to an eroded channel.

There was no development in the spillway areas which would suffer damage due to flow through the spillways.

d. Geology. The soils in the area of the dam and reservoir consist of low to medium plastic silty clays developed in modified loess. Depth to bedrock, which is interbedded limestone and shale is approximately 13 to 17 feet on the uplands.

The embankment itself consists of stiff, medium to highly plastic (CL to CH) clays.

The abutments are Quivira Shale overlain on the left abutment by 5 feet of low to highly plastic clays, and the foundation of the dam is the Wea Shale, with the Block Limestone present and outcropping in the middle dam area.

Samples of the embankment were taken near the center of the upstream crest using an Oakfield sampler. The materials in the samples consisted of stiff, medium to highly plastic (CL to CH) clays. Based on these samples and visual observations, it is surmised that the embankment consists of silty, sandy clay classified as (CL).

e. Reservoir Area. No slumping or slides of the reservoir banks were observed. The upstream end of lake contains some minor debris and a few trees. The lake was noted to be clean with little or no siltation.

Located immediately upstream of the Union Lake is a small earthen dam. This dam is approximately 240 feet long along the crest. The dam crest is approximately 8 feet wide and has a straight alinement. The elevation at the top of the dam is 926.5 and the dam has a storage volume of 9 ac-ft. No inspection was made except to determine the hydraulic parameters to perform the breaching analysis.

f. Downstream Channel. Each spillway discharges to an eroded channel, then to the natural streambed. The channel immediately downstream of the dam is lined with brush and trees and contains debris.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control.

The potential for sloughing, erosion, or sliding of embankment material is enhanced by the presence of the relatively steep side slopes and the narrow crest.

The growth of trees and brush, if allowed to go unchecked, could cause deterioration of the embankment. The roots of trees can loosen the embankment material and also can leave voids through which water can pass. Brush on the dam prevents inspection of the embankment and kills the smaller grasses whose roots are more effective in protecting the surface soil of the slope from erosion. The brush provides habitat for burrowing animals which can damage the embankment.

The erosion gullies on the downstream face of the embankment should be repaired.

The absence of adequate riprap and slope protection on the upstream slope of the dam has resulted in wave action erosion. If not corrected wave action will continue to erode the embankment and could lead to slope stability problems.

Open and displaced joints observed in the 30-inch primary spillway pipe are areas where potential internal erosion can occur. If this deficiency is not corrected, internal erosion and piping will continue to take place and could lead to spillway and embankment failure.

Burrowing animals will continue to damage the embankment if a program is not undertaken to eliminate them. Piping failure of embankments have resulted from damage caused by burrowing animals.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, and capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

There is no evidence that a maintenance program is in effect at this dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

A maintenance program should be developed and initiated. A program should include mowing of the grass cover and controlling tree growth on the embankment in order to discourage animal burrowing and root penetration problems.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Independence Quadrangle Map. The dam layout and topographic maps were provided by the owner and developed by Shafer, Kline, and Warren P.A. of Overland Park, Kansas. These topographic maps were used to develop the storage-elevation curves.

c. Visual Observations.

(1) The primary spillway appears to be in poor condition. The lake level at the time of the inspection (El. 907.3) was below the primary spillway inlet invert level. There were no obstructions to flow in the downstream channel.

(2) The secondary spillway conduits appear to be in less than fair condition. The lake level at the time of inspection was below their inlet elevations. The 12-inch concrete pipe spillway was essentially plugged with earth and debris and was not considered a discharge point for purposes of this report. The 16-inch corrugated metal pipe was open. The outlet ends of these pipes are located at an eroded channel at the right abutment.

(3) Spillway discharges do not endanger the integrity of the dam.

(4) Located immediately upstream from Union Lake's reservoir pool is a small earthen dam. This structure has an 18-inch corrugated metal pipe as its primary spillway.

d. Overtopping Potential. The spillways will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillways will pass 10 percent of the probable maximum flood without overtopping the dam. The spillways will not pass the one percent chance flood (100-year flood) developed from a 24-hour, one percent chance rainfall, but will pass the 10 percent chance flood (10-year flood) developed from a 24-hour, 10 percent chance rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the downstream hazard, the appropriate spillway design flood should be 100 percent of the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the

probable maximum flood overtopping the dam would be 524 cfs of the total discharge from the reservoir of 571 cfs. The estimated duration of overtopping is 5.2 hours with a maximum height of 1.3 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 1,142 cfs of the total discharge from the reservoir of 1,195 cfs. The estimated duration of overtopping is 7.3 hours with a maximum height of 1.8 feet. The embankment could be jeopardized should overtopping occur for these periods of time.

The hydraulic analysis for Union Lake includes the results of a breach analysis for the upstream impoundment.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately two miles downstream of the dam. More than five dwellings, three roads, Interstate I-435, one railroad yard, and miscellaneous industrial facilities could be severely damaged and lives could be lost should failure of the dam occur. Contents of the estimated downstream damage zone were verified by the inspection team. Union Lake and its downstream damage zone are located in a Zone C (Area of Minimal Flooding) as defined by the National Flood Insurance Program. Applicable flood plain regulations and other constraints are in force as per the flood insurance study effective September 29, 1978.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Postconstruction Changes. It is not known whether or not any repairs have been made to the dam subsequent to its construction.

e. Rehabilitation: The owners of Union Lake have engaged the firm of Shafer, Kline, and Warren, P.A. to prepare engineering documents for the rehabilitation of the dam and appurtenances. An engineering report and construction drawings have been prepared. Subsurface explorations were performed in conjunction with the above engineering study. Boring logs obtained during this effort are presented in Appendix B.

f. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry. Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored, controlled, and/or repaired. These are erosion on the downstream slope, extremely steep upstream and downstream slopes, erosion of upstream slope due to wave action, partially plugged spillway conduit, disjointed and displaced pipe sections, small sinkhole over the primary spillway pipe, spillway channels erosion, the dense growth of brush, and trees on the embankment, and animal burrows in the embankment. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the absence of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious enough questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. The condition of the primary spillway is a serious deficiency and it should be either repaired or replaced. In

addition, the spillway size and/or height of the dam would need to be increased or the lake level would need to be permanently lowered to increase available flood storage to effectivily pass the spillway design flood.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be carried out under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) Riprap should be placed on the upstream face of the dam to an elevation above the normal lake level to prevent wave induced erosion of the embankment material. The upstream slope should be cleared of all debris prior to placement of riprap.

(2) A maintenance program to remove and control the growth of brush and trees on the embankment should be developed. Grass/weed cover on the embankments should be cut periodically.

(3) The erosion gullies on the downstream slope of the embankment and the spillway channels should be repaired and protected with suitable materials. Paved ditches or other slope protection may be required to control the concentrated discharge from the spillways.

(4) The animal burrows in the embankment should be corrected since they can lead to piping. Control measures should be implemented to discourage this type of animal activity. The embankment slope should be monitored by a qualified engineer during the repair of the embankment.

(5) All debris and trash discarded on this structure and plugging in the secondary 12-inch diameter concrete pipe should be removed. Such accumulations not only give the appearance of poor maintenance but also can possibly hide potential problem areas.

(6) Seepage and stability analyses should be performed.

(7) A detailed inspection of the dam should be made periodically. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

(8) The inlet ends of the spillway pipes should have suitable trash racks installed.

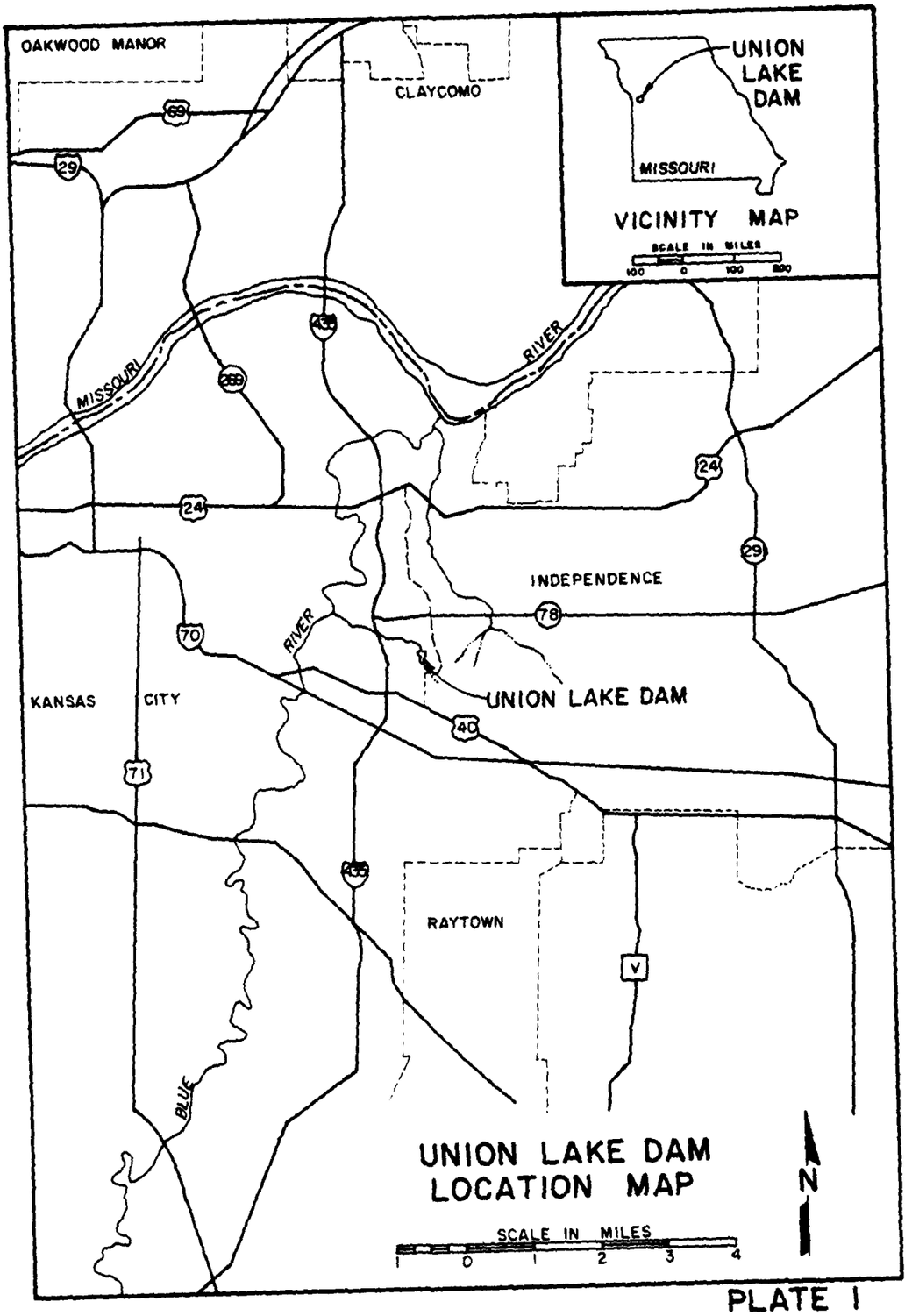

OAKWOOD MANOR
CLAYCOMO
UNION LAKE DAM
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
MISSOURI RIVER
INDEPENDENCE
KANSAS CITY
UNION LAKE DAM
RAYTOWN
BLUE RIVER
UNION LAKE DAM
LOCATION MAP
SCALE IN MILES
1 0 1 2 3 4
N

PLATE 1

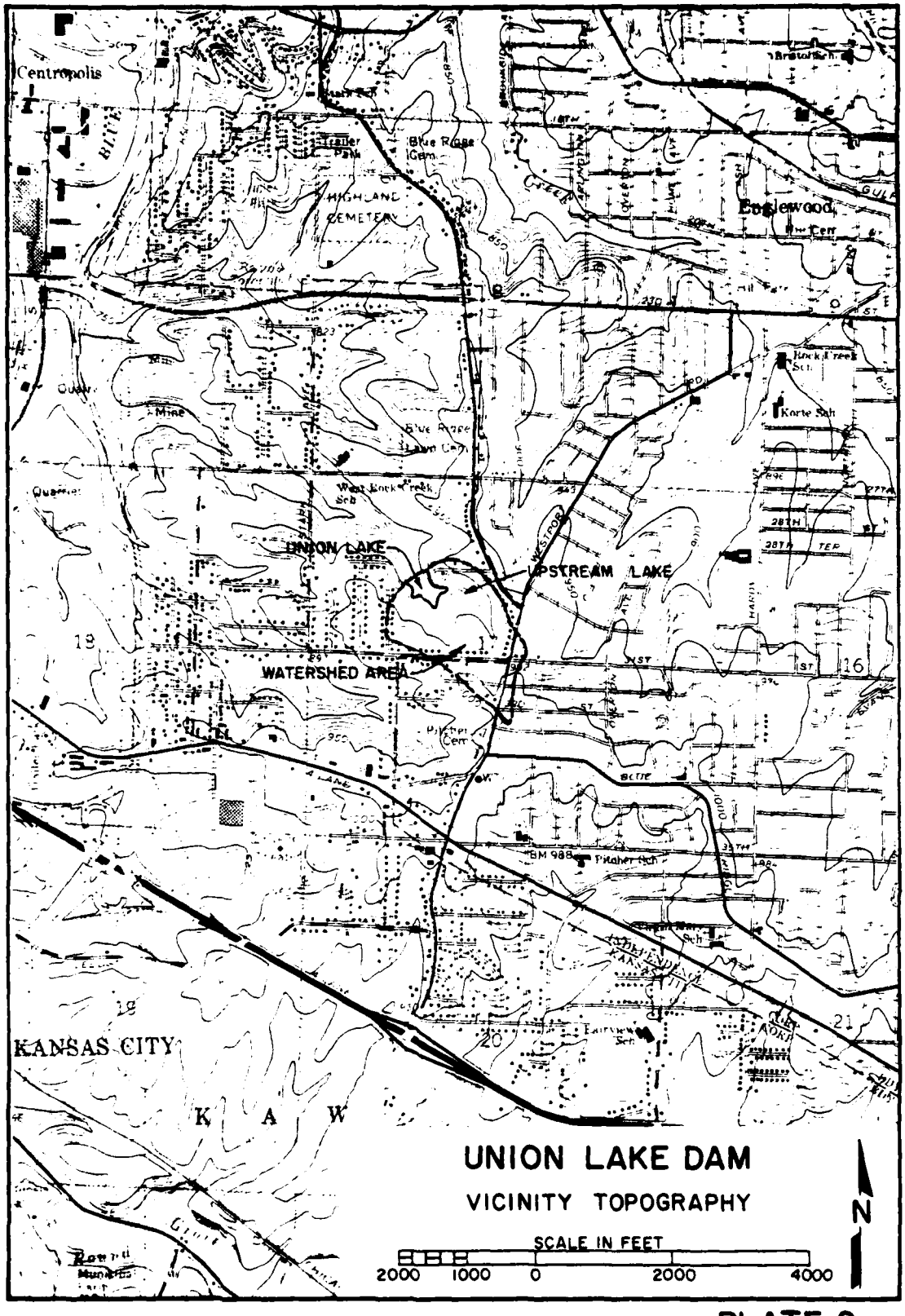

Centropolis
Englewood
HIGHLAND CEMETERY
Blue Rose Cem.
Trailer Park
Mine
Quarries
UNION LAKE
UPSTREAM LAKE
WATERSHED AREA
BM 988
KANSAS CITY
K A W
18
19
20
21
16
UNION LAKE DAM
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000
N

PLATE 2

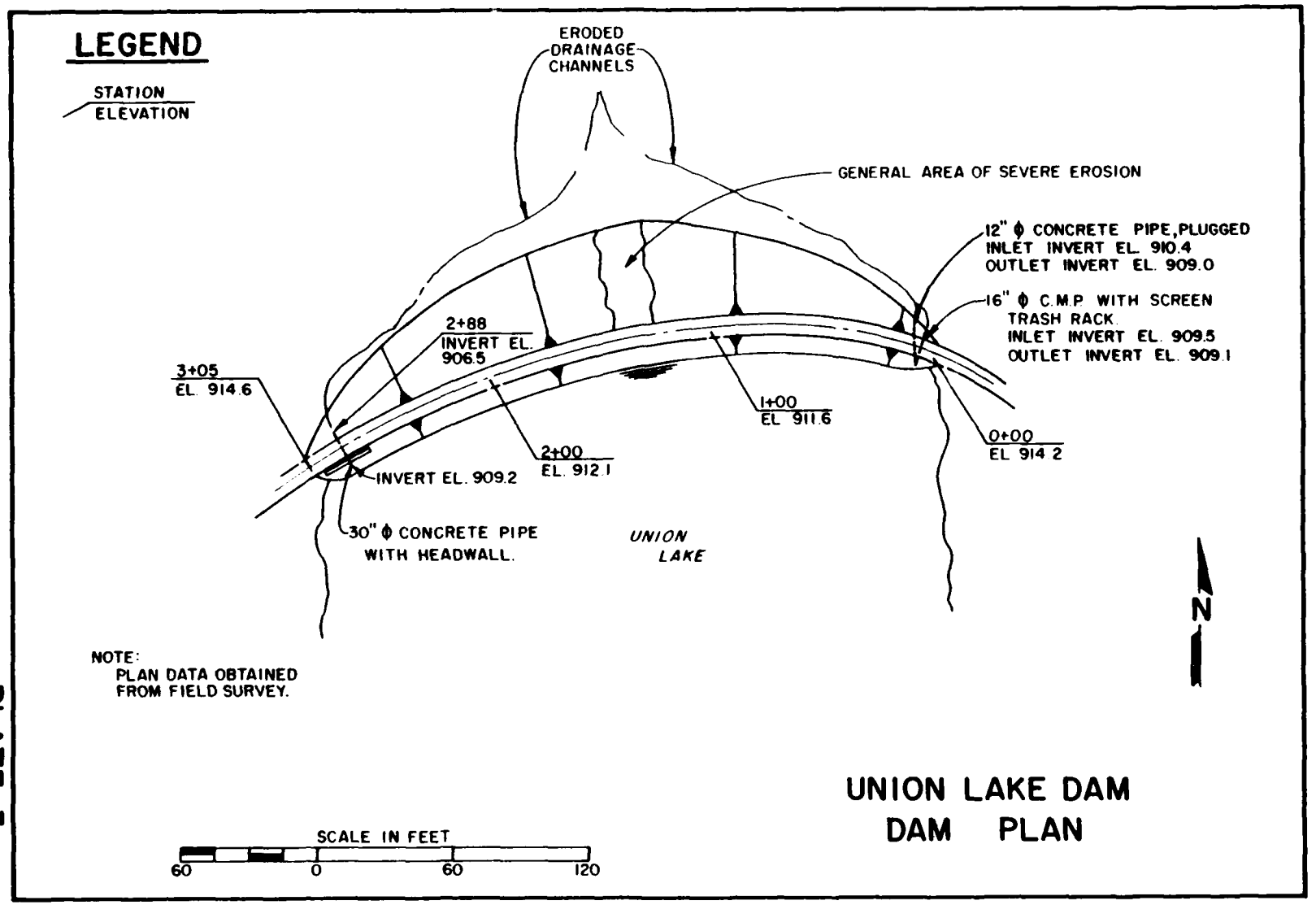
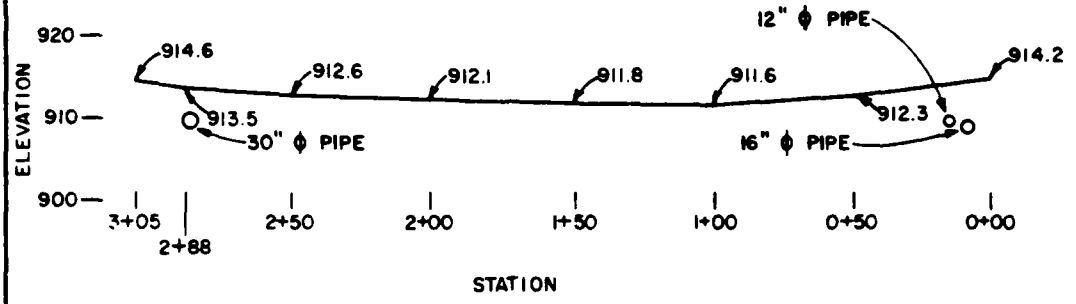
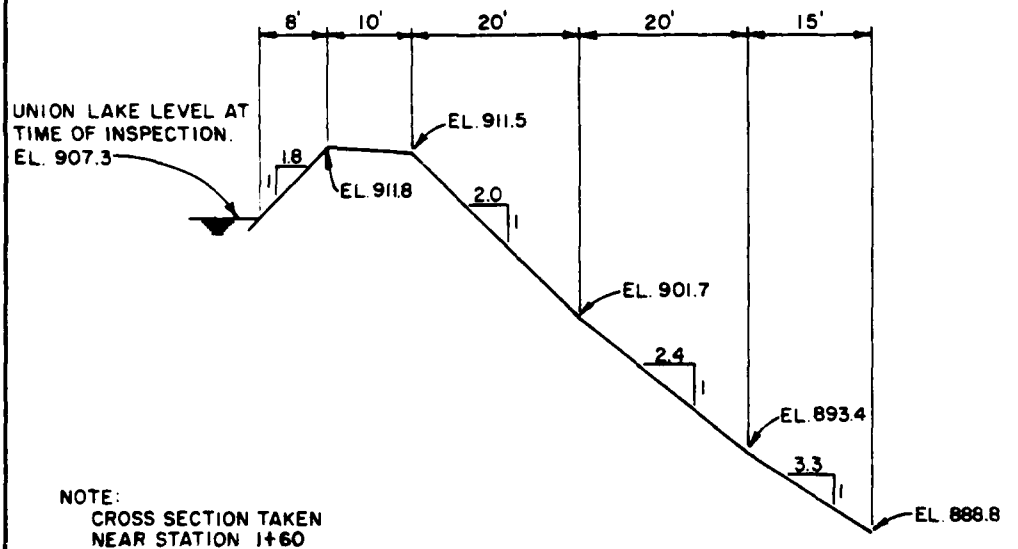


PLATE 3

UNION LAKE DAM
DAM PLAN



CREST PROFILE



CROSS SECTION

UNION LAKE DAM
DAM CREST PROFILE
DAM CROSS SECTION

PLATE 4

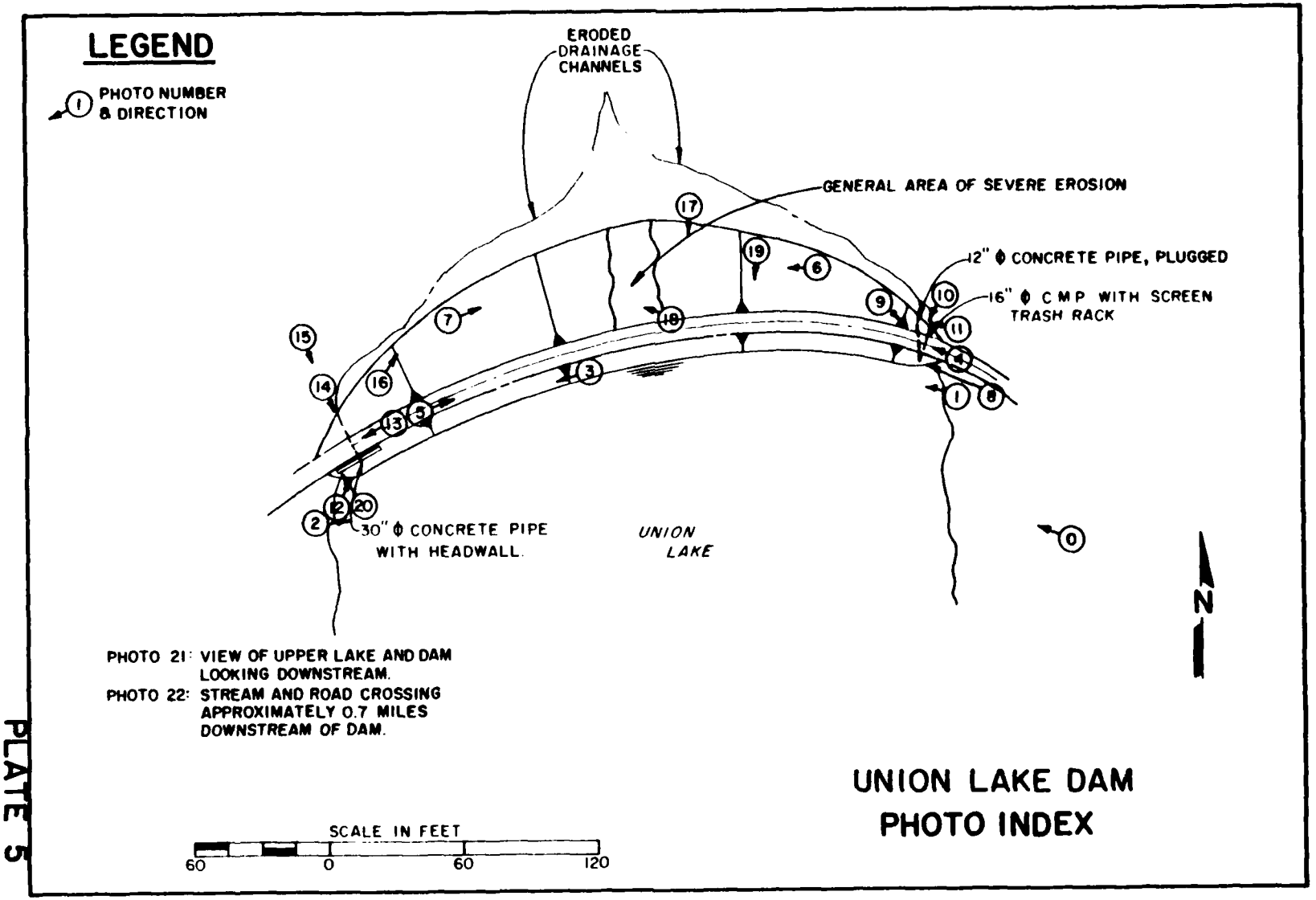

LEGEND
PHOTO NUMBER & DIRECTION
ERODED DRAINAGE CHANNELS
GENERAL AREA OF SEVERE EROSION
12" ϕ CONCRETE PIPE, PLUGGED
16" ϕ C M P WITH SCREEN TRASH RACK
30" ϕ CONCRETE PIPE WITH HEADWALL.
UNION LAKE
N
PHOTO 21: VIEW OF UPPER LAKE AND DAM LOOKING DOWNSTREAM.
PHOTO 22: STREAM AND ROAD CROSSING APPROXIMATELY 0.7 MILES DOWNSTREAM OF DAM.
SCALE IN FEET
60 0 60 120
UNION LAKE DAM
PHOTO INDEX

PLATE 5

PHOTO 1: UPSTREAM FACE OF DAM LOOKING WEST

PHOTO 2: UPSTREAM FACE OF DAM LOOKING EAST

PHOTO 3: UPSTREAM FACE OF DAM, LEFT CENTER

PHOTO 4: CREST OF DAM LOOKING WEST

PHOTO 5: CREST OF DAM LOOKING EAST

PHOTO 6: DOWNSTREAM FACE OF DAM LOOKING WEST

PHOTO 7: DOWNSTREAM FACE OF DAM LOOKING EAST

PHOTO 8: INLET END OF SECONDARY SPILLWAY PIPES, RIGHT END OF DAM

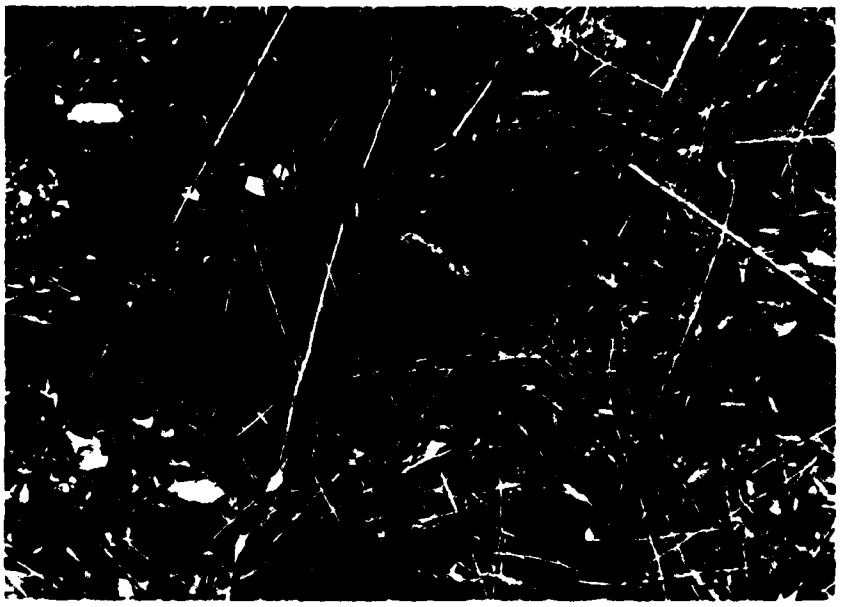


PHOTO 9: OUTLET END OF CONCRETE PIPE, RIGHT END OF DAM

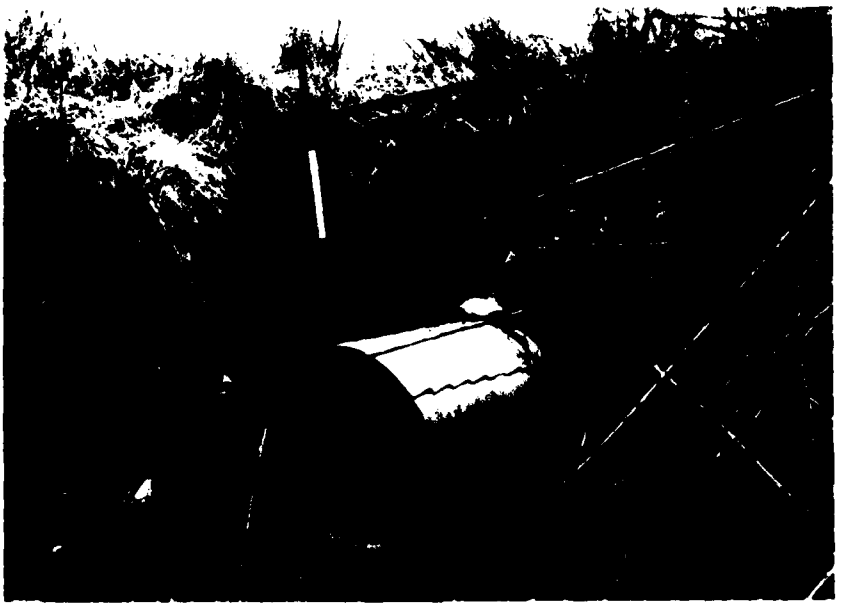


PHOTO 10: OUTLET END OF CORRUGATED METAL PIPE, RIGHT END OF DAM

PHOTO 11: CHANNEL DOWNSTREAM OF CORRUGATED METAL PIPE, RIGHT END OF DAM

PHOTO 12: INLET END OF PRIMARY SPILLWAY PIPE AT LEFT END OF DAM

PHOTO 13: SINK HOLE IN CREST AT SEPARATED JOINT IN PRIMARY SPILLWAY PIPE

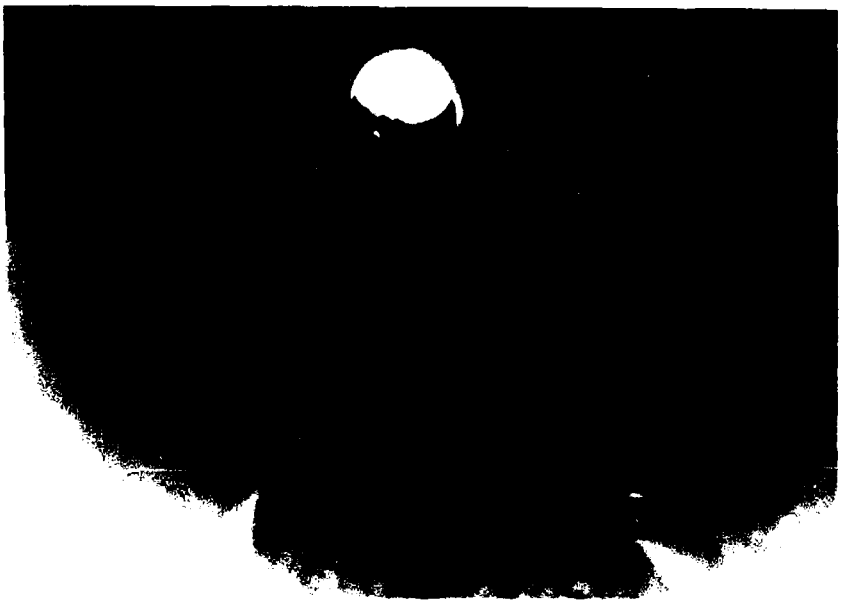


PHOTO 14: VIEW THROUGH PRIMARY SPILLWAY PIPE FROM DOWNSTREAM END

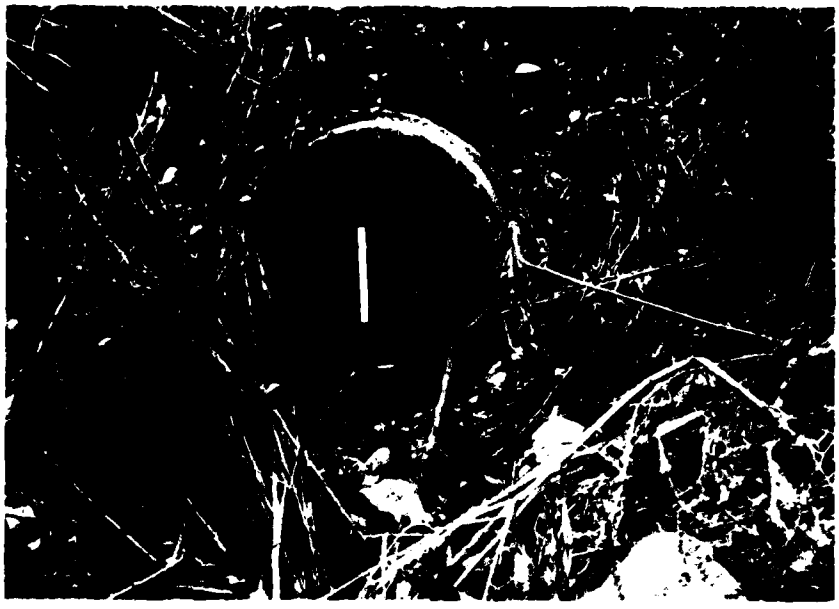


PHOTO 15: OUTLET END OF PRIMARY SPILLWAY PIPE AT LEFT END OF DAM

PHOTO 16: CHANNEL DOWNSTREAM OF PRIMARY SPILLWAY PIPE

PHOTO 17: EROSION ON DOWNSTREAM FACE OF DAM, RIGHT CENTER

PHOTO 18: EROSION ON DOWNSTREAM FACE OF DAM, RIGHT CENTER

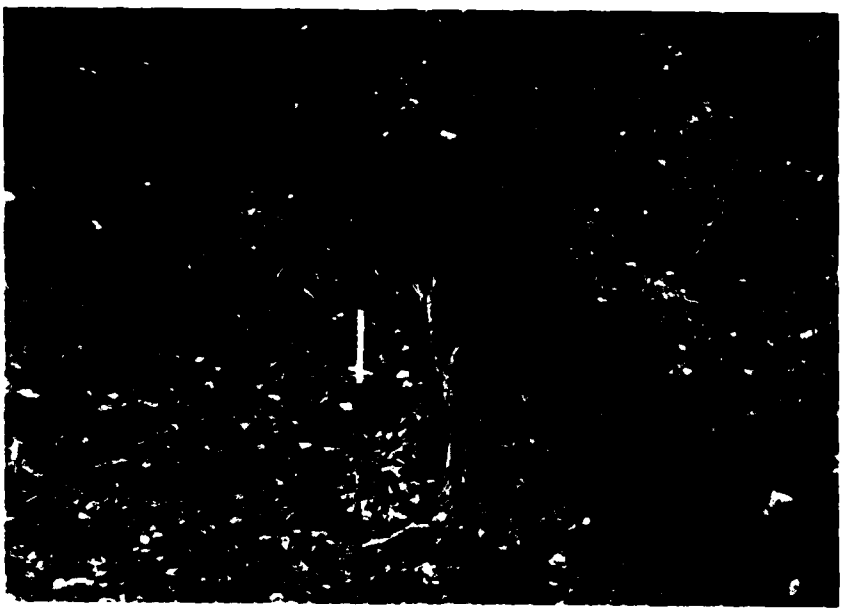


PHOTO 19: TEST PIT ON DOWNSTREAM EMBANKMENT SLOPE, TOE

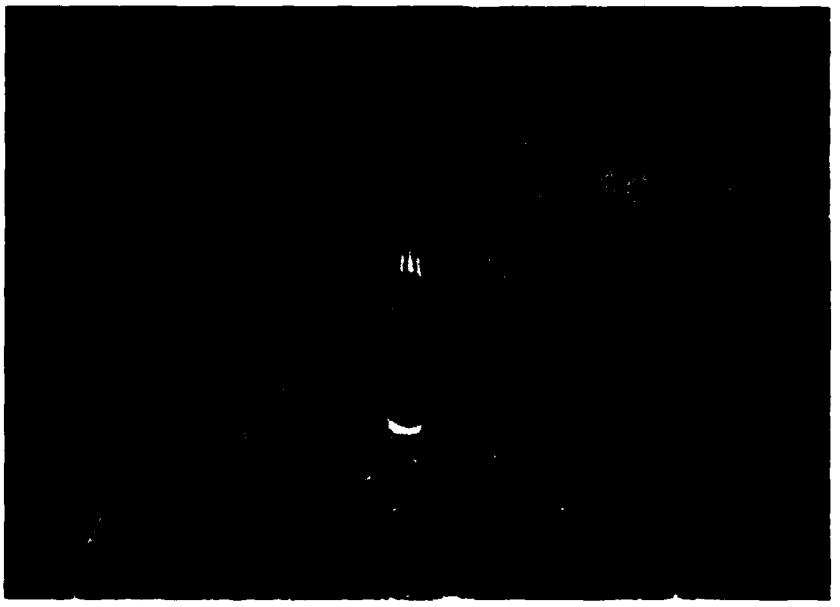


PHOTO 20: EROSION AT LEFT SIDE CONCRETE PRIMARY SPILLWAY HEADWALL

PHOTO 21: OVERVIEW OF UPPER LAKE AND DAM

PHOTO 22: VALLEY DOWNSTREAM OF DAM

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to synthetic unit hydrographs to develop the inflow hydrographs for Union Lake Dam and the upstream reservoir. The inflow hydrographs were then routed through the reservoirs and spillways. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33) (2). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411 (3). The Kansas City, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corps of Engineers, was used when the one and 10 percent chance probability floods were routed through the reservoirs and spillways.

The synthetic unit hydrographs for the watersheds were developed by the computer program using the Soil Conservation Service (SCS) method (1, 5). The parameters for the unit hydrographs are shown in Table 1. Lag time and time of concentration was calculated by two different methods. The results used in the analyses was obtained by using the Kerpich formula.

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used and the result from the computer output are shown in Table 2.

Storms were routed through the two reservoirs noted above. Routing through the reservoirs was performed using the modified Puls Method. The initial reservoir pool elevations for the routing of each storm were determined to be equivalent to the invert elevations of the primary spillways in accordance with antecedent storm conditions AMC II and AMC III preceding the one and ten percent probability and probable maximum storms as outlined by the U.S. Army Corps of Engineers, St. Louis District (4). The hydraulic capacity of the spillways and the storage capacities of the reservoirs were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curves for the spillways are shown in Table 4. The flow over the crests of the dams was determined using the nonlevel dam crest option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. The flow through the primary and secondary spillways was determined from nomographs for pipe culverts with inlet control. The 12-inch diameter secondary spillway in the lower lake was blocked with dirt and debris and was not used in the analysis.

Where routings through the upstream reservoir resulted in overtopping of that structure, a breach analysis was performed using HEC-1. The breaching parameters are noted in Table 5.

The results of the routing and breach analyses indicate that a flood equivalent to a maximum of 10 percent of the PMF will not overtop Union Lake Dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 6.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:	Upper Dam	Lower Dam**
Drainage Area (A)	31 acres	30 acres
Lag Time (L_g)	0.085 hours	0.09 hours
Time of Concentration (T_c)	0.14 hours	0.15 hours
Duration (D)	5 minutes	5 minutes

Unit Hydrograph Ordinates
Discharge (cfs)*

Time (Min.)*	Upper Dam	Lower Dam
0	0	0
5	139	120
10	156	152
15	54	58
20	19	21
25	6	8
30	2	3
35	1	1

* From HEC-1 Computer Output.
** Excludes Controlled Drainage Area Upstream.

FORMULAS USED:

$$T_c = (11.9\ L^3/H)^{0.385}$$

$$L_g = 0.6\ T_c$$

$$D = 0.133\ T_c$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
Upper Dam PMP	24	32.50	30.01	2.49
Lower Dam PMP	24	32.50	30.01	2.49
Upper Dam 100 yr.	24	7.59	3.57	4.02
Lower Dam 100 yr.	24	7.59	3.57	4.02

Additional Data:

1) 100 Percent of Drainage Area in Hydrologic Soil Group B(7).
60 Percent of the Land Use was Urban.
30 Percent of the Land Use was Timberland.
10 Percent of the Land Use was Grassland.

2) SCS Runoff Curve CN = 82 (AMC III) Lower Lake Dam
82 (AMC III) Upper Lake Dam
for the PMF (5).

3) SCS Runoff Curve CN = 65 (AMC II) Lower Lake Dam
65 (AMC II) Upper Lake Dam
for the one and 10 percent probability floods (5).

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
Lower Lake Dam			
*909.2	4	30	0
**909.5	4	31	0
***911.6	4.4	40	30
Upper Lake Dam			
*922.3	1	4	0
***926.5	1.3	9	13

*Primary spillway invert elevation
**Secondary spillway invert elevation
***Top of dam elevation

The relationships in Table 3 were developed from the Independence, Missouri. 7.5 minute quadrangle map, field measurements, and engineering documents provided by Shafer, Kline, and Warren, P.A.

TABLE 4

SPILLWAY RATING CURVES

Reservoir Elevation (ft-msl)	Primary Spillway Discharge (cfs)	Secondary Spillway Discharge (cfs)	Total Spillway Discharge (cfs)
Lower Lake Dam			
*909.2	0	0	0
909.5	0	0	0
910.3	11.3	4.3	15.6
**911.6	24	7.3	30.0
914	49	11	60
916	61	14	75
Upper Lake Dam			
*922.3	0	-	0
924.0	6.8	-	6.8
**926.5	13.2	-	13.2
927.0	14.5	-	14.5
929.0	18.0	-	18.0
931.0	20.0	-	20.0

*Primary Spillway Invert Elevation
**Top of Dam Elevation

METHOD USED:

Primary and Secondary Spillway Release Rates are based on Nomographs for a Pipe Culvert with Inlet Control (6).

TABLE 5

BREACHING PARAMETERS

	Upper Dam
Bottom Width of Breach (BRWID)	10 feet
Side Slope of Breach (z) (In feet horizontal to 1.0 feet vertical)	0.5
Elevation of Breach Bottom at Maximum Size of Breach (ELBM)	913.5 ft. m.s.l.
Time for Breach to Develop to Maximum Size (TFAIL)	1.0 hour
Elevation of Water Surface Which Will Cause Dam to Fail (FAILEL)	926.5 ft. m.s.l.

TABLE 6

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	0	*909.2	30	0	-
0.10	73	910.5	35	17	0
0.15	226	912.3	43	174	0.7
0.50	658	912.9	46	571	1.3
1.00	1,302	913.4	48	1,195	1.8

* Primary Spillway Inlet Elevation

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(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Modification April 1980, Davis, California.

(2) HMR 33, Seasonal Variations of Probable Maximum Precipitation, East of the 105th Meridian for Areas 10 to 1000 Square Miles and Durations from 6 to 48 Hours, U.S. Department of Commerce, NOAA, National Weather Service, 1956.

(3) EM-1110-2-1411, Standard Project Flood Determinations, U.S. Army Corps of Engineers, 26 March 1952.

(4) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/ Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 22 August 1980.

(5) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(6) U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Charts For The Selection Of Highway Culverts, December 1965.

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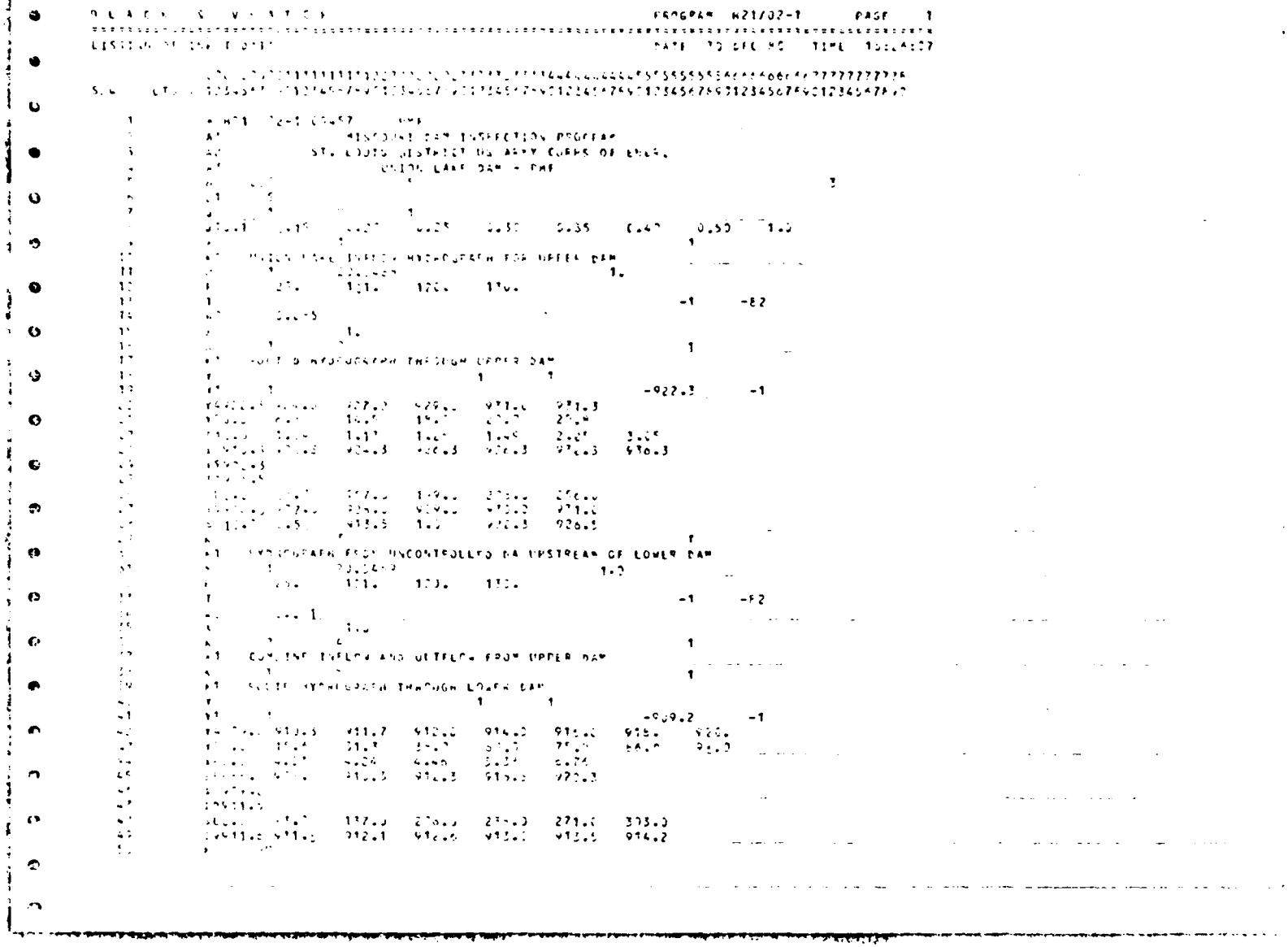

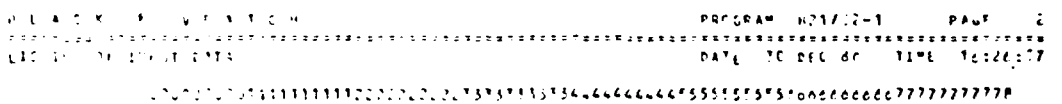

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MISSOURI DAM INSPECTION PROGRAM
S. LOUIS DISTRICT US ARMY CORPS OF ENGR.
UNION LAKE DAM - PMF

                    JOB SPECIFICATION
   NQ    NHR   NMIN   IDAY    IHR   IMIN  METRC   IPLT   IPRT  NSTAN
                  5      0      0      0      0      0      3      0
                       JOPER    NWT  LROPT  TRACE
                          5      0      0      0

           MULTI-PLAN ANALYSES TO BE PERFORMED
              NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS=  .10   .15   .20   .25   .30   .35   .40   .50  1.00

**********     **********     **********     **********     **********

                   SUB-AREA RUNOFF COMPUTATION

UNION LAKE INFLOW HYDROGRAPH FOR UPPER DAM

   ISTAQ  ICOMP  IECON  ITAPE   JPLT   JPRT  INAME ISTAGE  IAUTO
       1      0      0      0      0      0      1      0      0

                      HYDROGRAPH DATA
  IHYDG  IUHG  TAREA   SNAP  TRSDA  TRSPC  RATIO  ISNOW  ISAME  LOCAL
      1     2    .05    .00    .05   1.00   .000      0      0      0

                        PRECIP DATA
        SPFE    PMS     R6    R12    R24    R48    R72    R96
         .00  25.00 101.00 120.00 130.00    .00    .00    .00

                         LOSS DATA
 LROPT  STRKR  DLTKR  RTIOL  ERAIN  STRKS  RTIOK  STRTL  CNSTL  ALSMX  RTIMP
     0    .00    .00   1.00    .00    .00   1.00  -1.00 -82.00    .00    .00

CURVE NO = -82.00  WETNESS =  -1.00  EFFECT CN =  82.00

                    UNIT HYDROGRAPH DATA
                  TC=   .00   LAG=   .08

                       RECESSION DATA
        STRTQ=    .00   QRCSN=    .00   RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH  7 END OF PERIOD ORDINATES, TC=    .00 HOURS, LAG=   .08  VOL= 1.00
   133.    154.     54.     12.      6.      2.      1.
```

END-OF-PERIOD FLOW

HYDR	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HYDR	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	0.05	1	.01	.00	.01	0.	1.01	12.05	145	.21	.19	.02	61.
1.01	0.10	2	.01	.00	.01	0.	1.01	12.10	146	.21	.19	.02	62.
1.01	0.15	3	.01	.00	.01	0.	1.01	12.15	147	.21	.19	.02	70.
1.01	0.20	4	.01	.00	.01	0.	1.01	12.20	148	.21	.20	.01	72.
1.01	0.25	5	.01	.00	.01	0.	1.01	12.25	149	.21	.20	.01	73.
1.01	0.30	6	.01	.00	.01	0.	1.01	12.30	150	.21	.20	.01	74.
1.01	0.35	7	.01	.00	.01	0.	1.01	12.35	151	.21	.20	.01	74.
1.01	0.40	8	.01	.00	.01	0.	1.01	12.40	152	.21	.20	.01	75.
1.01	0.45	9	.01	.00	.01	0.	1.01	12.45	153	.21	.20	.01	75.
1.01	0.50	10	.01	.00	.01	0.	1.01	12.50	154	.21	.20	.01	75.
1.01	0.55	11	.01	.00	.01	0.	1.01	12.55	155	.21	.20	.01	75.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.21	.20	.01	75.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.25	.24	.01	81.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.25	.24	.01	86.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.25	.24	.01	90.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.25	.24	.01	91.
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.25	.24	.01	91.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.25	.24	.01	92.
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.25	.24	.01	92.
1.01	1.40	20	.01	.00	.01	0.	1.01	13.40	164	.25	.24	.01	92.
1.01	1.45	21	.01	.00	.01	0.	1.01	13.45	165	.25	.24	.01	92.
1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.25	.24	.01	92.
1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.25	.24	.01	92.
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.25	.25	.01	93.
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.32	.31	.01	101.
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.32	.31	.01	111.
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.32	.31	.01	114.
1.01	2.20	28	.01	.00	.01	0.	1.01	14.20	172	.32	.31	.01	116.
1.01	2.25	29	.01	.00	.01	0.	1.01	14.25	173	.32	.31	.01	116.
1.01	2.30	30	.01	.00	.01	0.	1.01	14.30	174	.32	.31	.01	116.
1.01	2.35	31	.01	.00	.01	0.	1.01	14.35	175	.32	.31	.01	117.
1.01	2.40	32	.01	.00	.01	0.	1.01	14.40	176	.32	.31	.01	117.
1.01	2.45	33	.01	.00	.01	0.	1.01	14.45	177	.32	.31	.01	117.
1.01	2.50	34	.01	.00	.01	0.	1.01	14.50	178	.32	.31	.01	117.
1.01	2.55	35	.01	.00	.01	0.	1.01	14.55	179	.32	.31	.01	117.
1.01	3.00	36	.01	.00	.01	0.	1.01	15.00	180	.32	.31	.01	117.
1.01	3.05	37	.01	.00	.01	0.	1.01	15.05	181	.19	.19	.00	100.
1.01	3.10	38	.01	.00	.01	0.	1.01	15.10	182	.38	.38	.01	108.
1.01	3.15	39	.01	.00	.01	0.	1.01	15.15	183	.38	.38	.01	111.
1.01	3.20	40	.01	.00	.01	0.	1.01	15.20	184	.58	.57	.01	169.
1.01	3.25	41	.01	.00	.01	0.	1.01	15.25	185	.67	.66	.01	210.
1.01	3.30	42	.01	.00	.01	1.	1.01	15.30	186	1.63	1.61	.02	366.
1.01	3.35	43	.01	.00	.01	1.	1.01	15.35	187	2.69	2.66	.03	671.
1.01	3.40	44	.01	.00	.01	1.	1.01	15.40	188	1.06	1.05	.01	666.
1.01	3.45	45	.01	.00	.01	1.	1.01	15.45	189	.67	.67	.01	436.
1.01	3.50	46	.01	.00	.01	1.	1.01	15.50	190	.58	.57	.00	303.
1.01	3.55	47	.01	.00	.01	1.	1.01	15.55	191	.38	.38	.00	219.
1.01	4.00	48	.01	.00	.01	1.	1.01	16.00	192	.38	.38	.00	170.
1.01	4.05	49	.01	.00	.01	1.	1.01	16.05	193	.29	.29	.00	140.
1.01	4.10	50	.01	.00	.01	1.	1.01	16.10	194	.29	.29	.00	120.
1.01	4.15	51	.01	.00	.01	1.	1.01	16.15	195	.29	.29	.00	114.
1.01	4.20	52	.01	.00	.01	1.	1.01	16.20	196	.29	.29	.00	112.
1.01	4.25	53	.01	.00	.01	1.	1.01	16.25	197	.29	.29	.00	111.

FLOOD HYDROGRAPH PACKAGE - HEC-1 PROGRAM H21A32-1V TIME 16:26:19 CASE RMF

1.01	.01	74	.01	.03	.01	1.	1.01	16.10	198	.02	.02	.00	111.
1.01	.01	75	.01	.03	.01	1.	1.01	16.15	199	.02	.02	.00	111.
1.01	.01	75	.01	.03	.01	1.	1.01	16.20	200	.02	.02	.00	111.
1.01	.01	76	.01	.03	.01	1.	1.01	16.25	201	.02	.02	.00	111.
1.01	.01	76	.01	.03	.01	1.	1.01	16.30	202	.02	.02	.00	111.
1.01	.01	77	.01	.03	.01	1.	1.01	16.35	203	.02	.02	.00	111.
1.01	.01	78	.01	.03	.01	1.	1.01	16.40	204	.02	.02	.00	111.
1.01	.01	78	.01	.03	.01	1.	1.01	16.45	205	.02	.02	.00	102.
1.01	.01	79	.01	.03	.01	1.	1.01	16.50	206	.02	.02	.00	92.
1.01	.01	80	.01	.03	.01	2.	1.01	16.55	207	.02	.02	.00	89.
1.01	.01	80	.01	.03	.01	2.	1.01	17.00	208	.02	.02	.00	87.
1.01	.01	81	.01	.03	.01	2.	1.01	17.05	209	.02	.02	.00	87.
1.01	.01	81	.01	.03	.01	2.	1.01	17.10	210	.02	.02	.00	87.
1.01	.01	82	.01	.03	.01	2.	1.01	17.15	211	.02	.02	.00	87.
1.01	.01	82	.01	.03	.01	2.	1.01	17.20	212	.02	.02	.00	87.
1.01	.01	83	.01	.03	.01	2.	1.01	17.25	213	.02	.02	.00	87.
1.01	.01	83	.01	.03	.01	2.	1.01	17.30	214	.02	.02	.00	87.
1.01	.01	84	.01	.03	.01	2.	1.01	17.35	215	.02	.02	.00	87.
1.01	.01	84	.01	.03	.01	2.	1.01	17.40	216	.02	.02	.00	87.
1.01	.01	85	.01	.03	.01	2.	1.01	17.45	217	.02	.02	.00	87.
1.01	.01	85	.01	.03	.01	2.	1.01	17.50	218	.02	.02	.00	87.
1.01	.01	86	.01	.03	.01	2.	1.01	17.55	219	.02	.02	.00	87.
1.01	.01	86	.01	.03	.01	2.	1.01	18.00	220	.02	.02	.00	87.
1.01	.01	87	.01	.03	.01	2.	1.01	18.05	221	.02	.02	.00	87.
1.01	.01	87	.01	.03	.01	2.	1.01	18.10	222	.02	.02	.00	87.
1.01	.01	88	.01	.03	.01	2.	1.01	18.15	223	.02	.02	.00	87.
1.01	.01	88	.01	.03	.01	2.	1.01	18.20	224	.02	.02	.00	87.
1.01	.01	89	.01	.03	.01	2.	1.01	18.25	225	.02	.02	.00	87.
1.01	.01	89	.01	.03	.01	2.	1.01	18.30	226	.02	.02	.00	87.
1.01	.01	90	.01	.03	.01	2.	1.01	18.35	227	.02	.02	.00	87.
1.01	.01	90	.01	.03	.01	2.	1.01	18.40	228	.02	.02	.00	87.
1.01	.01	91	.01	.03	.01	2.	1.01	18.45	229	.02	.02	.00	87.
1.01	.01	91	.01	.03	.01	2.	1.01	18.50	230	.02	.02	.00	87.
1.01	.01	92	.01	.03	.01	2.	1.01	18.55	231	.02	.02	.00	87.
1.01	.01	92	.01	.03	.01	2.	1.01	19.00	232	.02	.02	.00	87.
1.01	.01	93	.01	.03	.01	2.	1.01	19.05	233	.02	.02	.00	87.
1.01	.01	93	.01	.03	.01	2.	1.01	19.10	234	.02	.02	.00	87.
1.01	.01	94	.01	.03	.01	2.	1.01	19.15	235	.02	.02	.00	87.
1.01	.01	94	.01	.03	.01	2.	1.01	19.20	236	.02	.02	.00	87.
1.01	.01	95	.01	.03	.01	2.	1.01	19.25	237	.02	.02	.00	87.
1.01	.01	95	.01	.03	.01	2.	1.01	19.30	238	.02	.02	.00	87.
1.01	.01	96	.01	.03	.01	2.	1.01	19.35	239	.02	.02	.00	87.
1.01	.01	96	.01	.03	.01	2.	1.01	19.40	240	.02	.02	.00	87.
1.01	.01	97	.01	.03	.01	2.	1.01	19.45	241	.02	.02	.00	87.
1.01	.01	97	.01	.03	.01	2.	1.01	19.50	242	.02	.02	.00	87.
1.01	.01	98	.01	.03	.01	2.	1.01	19.55	243	.02	.02	.00	87.
1.01	.01	98	.01	.03	.01	2.	1.01	20.00	244	.02	.02	.00	87.
1.01	.01	99	.01	.03	.01	2.	1.01	20.05	245	.02	.02	.00	87.
1.01	.01	99	.01	.03	.01	2.	1.01	20.10	246	.02	.02	.00	87.
1.01	.01	100	.01	.03	.01	2.	1.01	20.15	247	.02	.02	.00	87.
1.01	.01	100	.01	.03	.01	2.	1.01	20.20	248	.02	.02	.00	87.
1.01	.01	101	.01	.03	.01	2.	1.01	20.25	249	.02	.02	.00	87.
1.01	.01	101	.01	.03	.01	2.	1.01	20.30	250	.02	.02	.00	87.
1.01	.01	102	.01	.03	.01	2.	1.01	20.35	251	.02	.02	.00	87.
1.01	.01	102	.01	.03	.01	2.	1.01	20.40	252	.02	.02	.00	87.
1.01	.01	103	.01	.03	.01	2.	1.01	20.45	253	.02	.02	.00	87.

1.01	9.10	111	.07	.05	.01	20.	1.01	21.10	254	.02	.02	.00	8.
1.01	9.15	111	.07	.05	.01	21.	1.01	21.15	255	.02	.02	.00	8.
1.01	9.20	112	.07	.05	.01	21.	1.01	21.20	256	.02	.02	.00	8.
1.01	9.25	113	.07	.06	.01	21.	1.01	21.25	257	.02	.02	.00	8.
1.01	9.30	114	.07	.06	.01	21.	1.01	21.30	258	.02	.02	.00	8.
1.01	9.35	115	.07	.06	.01	21.	1.01	21.35	259	.02	.02	.00	8.
1.01	9.40	116	.07	.06	.01	21.	1.01	21.40	260	.02	.02	.00	8.
1.01	9.45	117	.07	.06	.01	21.	1.01	21.45	261	.02	.02	.00	8.
1.01	9.50	118	.07	.06	.01	21.	1.01	21.50	262	.02	.02	.00	8.
1.01	9.55	119	.07	.06	.01	21.	1.01	21.55	263	.02	.02	.00	8.
1.01	10.00	120	.07	.06	.01	21.	1.01	22.00	264	.02	.02	.00	8.
1.01	10.05	121	.07	.06	.01	21.	1.01	22.05	265	.02	.02	.00	8.
1.01	10.10	122	.07	.06	.01	22.	1.01	22.10	266	.02	.02	.00	8.
1.01	10.15	123	.07	.06	.01	22.	1.01	22.15	267	.02	.02	.00	8.
1.01	10.20	124	.07	.06	.01	22.	1.01	22.20	268	.02	.02	.00	8.
1.01	10.25	125	.07	.06	.01	22.	1.01	22.25	269	.02	.02	.00	8.
1.01	10.30	126	.07	.06	.01	22.	1.01	22.30	270	.02	.02	.00	8.
1.01	10.35	127	.07	.06	.01	22.	1.01	22.35	271	.02	.02	.00	8.
1.01	10.40	128	.07	.06	.01	22.	1.01	22.40	272	.02	.02	.00	8.
1.01	10.45	129	.07	.06	.01	22.	1.01	22.45	273	.02	.02	.00	8.
1.01	10.50	130	.07	.06	.01	22.	1.01	22.50	274	.02	.02	.00	8.
1.01	10.55	131	.07	.06	.01	22.	1.01	22.55	275	.02	.02	.00	8.
1.01	11.00	132	.07	.06	.01	22.	1.01	23.00	276	.02	.02	.00	8.
1.01	11.05	133	.07	.06	.01	22.	1.01	23.05	277	.02	.02	.00	8.
1.01	11.10	134	.07	.06	.01	22.	1.01	23.10	278	.02	.02	.00	8.
1.01	11.15	135	.07	.06	.01	22.	1.01	23.15	279	.02	.02	.00	8.
1.01	11.20	136	.07	.06	.01	22.	1.01	23.20	280	.02	.02	.00	8.
1.01	11.25	137	.07	.06	.01	22.	1.01	23.25	281	.02	.02	.00	8.
1.01	11.30	138	.07	.06	.01	22.	1.01	23.30	282	.02	.02	.00	8.
1.01	11.35	139	.07	.06	.01	23.	1.01	23.35	283	.02	.02	.00	8.
1.01	11.40	140	.07	.06	.01	23.	1.01	23.40	284	.02	.02	.00	8.
1.01	11.45	141	.07	.06	.01	23.	1.01	23.45	285	.02	.02	.00	8.
1.01	11.50	142	.07	.06	.01	23.	1.01	23.50	286	.02	.02	.00	8.
1.01	11.55	143	.07	.06	.01	23.	1.01	23.55	287	.02	.02	.00	8.
1.01	12.00	144	.07	.06	.01	23.	1.02	.00	288	.02	.02	.00	8.
									SUM	72.50	35.21	2.69	11561.
										(825.)(	762.)(	63.)(	321.14)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	671.	129.	39.	39.	11722.
CMS	19.	4.	1.	1.	321.
INCHES		24.61	29.99	29.99	29.99
MM		625.19	761.40	761.40	761.40
AC-FT		64.	78.	78.	78.
THOUS CU M		79.	96.	96.	96.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	67.	13.	4.	4.	1132.
CMS	2.	0.	0.	0.	32.
INCHES		2.46	3.00	3.00	3.00
MM		62.52	76.14	76.14	76.14

INCHES	[illegible]	14.??	14.?9	14.??
MM	3??.??	???.??	???.??	3??.70
AC-FT	?2.	??.	39.	3?.
THOUS CU M	?9.	4?.	4?.	4?.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO ?

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	???.	1??.	??.	??.	??7?2.
CMS	??.	4.	1.	1.	?21.
INCHES		24.61	29.9?	29.98	29.98
MM		6??.?0	761.4?	?61.40	761.4?
AC-FT		?4.	7?.	72.	7?.
THOUS CU M		7?.	??.	?6.	96.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTED HYDROGRAPH THROUGH UPPER DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

[illegible] VEATCH

FLOOD HYDROGRAPH PACKAGE - [illegible]

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PROGRAM H21/?2-1V TIME 16:26:18 CASE PMF

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
.0	.0?0	.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-922.	-1

STAGE	9??.??	924.00	927.00	9??.00	931.00	931.30	
FLOW	.?0	?.?0	14.50	18.00	20.?0	20.80	
SURFACE AREA=	?.	?.	1.	1.	1.	2.	?.
CAPACITY=	?.	4.	6.	?.	11.	1?.	29.
ELEVATION=	91?.	?22.	924.	926.	92?.	932.	93?.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
92?.?	.0	.0	.0	.0	.0	.0	.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
926.5	.0	.0	0.

CREST LENGTH AT OR BELOW ELEVATION	.	??.	157.	1??.	228.	256.
	?26.?	927.?	92?.?	929.0	930.0	931.0

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
1?.	.50	91?.??	1.?0	922.?0	?26.50

[illegible]

SUB-AREA RUNOFF COMPUTATION

HYDROGRAPH FROM UNCONTROLLED DA UPSTREAM OF LOWER DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	6	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.07	.00	.05	1.00	.000	0	0	0

SPECIF DATA

TSPE	PMS	R1	R12	R24	R48	R72	R96
.0	25.00	100.00	100.00	100.00	.00	.00	.00

LOSS DATA

LOSS	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
2	.00	.00	1.00	.00	.00	1.00	-1.00	-82.00	.00	.00

CURVE NO = -82.00 WETNESS = -1.00 EFFECT CN = 82.00

UNIT HYDROGRAPH DATA

TC= .00 LAG= .00

RECESSION DATA

STRTQ= .10 QRCSN= .00 RTIOR= 1.00

*** ATTEMPT TOO LARGE--(NPD IS 67 LAG/2)

UNIT HYDROGRAPH 7 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= .00 VOL= 1.00

1.	100.	59.	21.	5.	1.		

END-OF-PERIOD FLOW

HYDRO	AREA	PERIOD	RAIN	EXCS	LOSS	COMP Q		TO.DR	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.00	.07	1	.01	.00	.01	0.		1.01	12.05	145	.21	.19	.02	38.
1.00	.07	2	.01	.00	.01	0.		1.01	12.10	146	.21	.19	.02	58.
1.00	.07	3	.01	.00	.01	0.		1.01	12.15	147	.21	.19	.02	66.
1.00	.07	4	.01	.00	.01	0.		1.01	12.20	148	.21	.20	.01	69.
1.00	.07	5	.01	.00	.01	0.		1.01	12.25	149	.21	.20	.01	70.
1.00	.07	6	.01	.00	.01	0.		1.01	12.30	150	.21	.20	.01	71.
1.00	.07	7	.01	.00	.00	0.		1.01	12.35	151	.21	.20	.01	71.
1.00	.07	8	.01	.00	.01	0.		1.01	12.40	152	.21	.20	.01	72.
1.00	.07	9	.01	.00	.01	0.		1.01	12.45	153	.21	.20	.01	72.
1.00	.07	10	.01	.00	.01	0.		1.01	12.50	154	.21	.20	.01	72.
1.00	.07	11	.01	.00	.01	0.		1.01	12.55	155	.21	.20	.01	72.
1.00	.07	12	.01	.00	.01	0.		1.01	13.00	156	.21	.20	.01	72.
1.00	.07	13	.01	.00	.01	0.		1.01	13.05	157	.21	.20	.01	73.
1.00	.07	14	.01	.00	.01	0.		1.01	13.10	158	.21	.20	.01	84.
1.00	.07	15	.01	.00	.01	0.		1.01	13.15	159	.21	.20	.01	86.

1.01	1.20	15	.01	.02	.01	0.	1.01	17.20	160	.25	.24	.01	87.
1.01	1.20	17	.01	.02	.01	0.	1.01	17.25	161	.25	.24	.01	88.
1.01	1.21	18	.01	.02	.01	0.	1.01	17.30	162	.25	.24	.01	88.
1.01	1.21	19	.01	.02	.01	0.	1.01	17.35	163	.25	.24	.01	88.
1.01	1.21	20	.01	.02	.01	0.	1.01	17.40	164	.25	.24	.01	88.
1.01	1.21	21	.01	.02	.01	0.	1.01	17.45	165	.25	.24	.01	89.
1.01	1.21	22	.01	.02	.01	0.	1.01	17.50	166	.25	.24	.01	89.
1.01	1.21	23	.01	.02	.01	0.	1.01	17.55	167	.25	.24	.01	89.
1.01	1.21	24	.01	.03	.01	0.	1.01	18.00	168	.25	.25	.01	89.
1.01	1.22	25	.01	.03	.01	0.	1.01	18.05	169	.32	.31	.01	96.
1.01	1.22	26	.01	.03	.01	0.	1.01	18.10	170	.32	.31	.01	100.
1.01	1.22	27	.01	.03	.01	0.	1.01	18.15	171	.32	.31	.01	100.
1.01	1.22	28	.01	.03	.01	0.	1.01	18.20	172	.32	.31	.01	101.
1.01	1.23	29	.01	.03	.01	0.	1.01	18.25	173	.32	.31	.01	102.
1.01	1.23	30	.01	.03	.01	0.	1.01	18.30	174	.32	.31	.01	102.
1.01	1.23	31	.01	.03	.01	0.	1.01	18.35	175	.32	.31	.01	102.
1.01	1.23	32	.01	.03	.01	0.	1.01	18.40	176	.32	.31	.01	102.
1.01	1.24	33	.01	.03	.01	0.	1.01	18.45	177	.32	.31	.01	102.
1.01	1.24	34	.01	.03	.01	0.	1.01	18.50	178	.32	.31	.01	102.
1.01	1.24	35	.01	.03	.01	0.	1.01	18.55	179	.32	.31	.01	102.
1.01	1.24	36	.01	.03	.01	0.	1.01	19.00	180	.32	.31	.01	103.
1.01	1.24	37	.01	.03	.01	0.	1.01	19.05	181	.19	.19	.00	98.
1.01	1.25	38	.01	.03	.01	0.	1.01	19.10	182	.38	.38	.01	102.
1.01	1.25	39	.01	.03	.01	0.	1.01	19.15	183	.38	.38	.01	104.
1.01	1.25	40	.01	.03	.01	0.	1.01	19.20	184	.59	.57	.01	155.
1.01	1.25	41	.01	.03	.01	0.	1.01	19.25	185	.67	.66	.01	199.
1.01	1.26	42	.01	.03	.01	1.	1.01	19.30	186	1.63	1.61	.02	339.
1.01	1.26	43	.01	.03	.01	1.	1.01	19.35	187	2.69	2.66	.03	620.
1.01	1.26	44	.01	.03	.01	1.	1.01	19.40	188	1.06	1.05	.01	644.
1.01	1.26	45	.01	.03	.01	1.	1.01	19.45	189	.67	.67	.01	635.
1.01	1.27	46	.01	.03	.01	1.	1.01	19.50	190	.58	.57	.02	532.
1.01	3.35	47	.01	.03	.01	1.	1.01	19.55	191	.38	.38	.00	219.
1.01	4.10	48	.01	.03	.01	1.	1.01	20.00	192	.38	.38	.00	168.
1.01	4.17	49	.01	.03	.01	1.	1.01	20.05	193	.29	.29	.00	170.
1.01	4.23	50	.01	.03	.01	1.	1.01	20.10	194	.29	.29	.00	117.
1.01	4.25	51	.01	.03	.01	1.	1.01	20.15	195	.29	.29	.00	110.
1.01	4.26	52	.01	.03	.01	1.	1.01	20.20	196	.29	.29	.00	107.
1.01	4.28	53	.01	.03	.01	1.	1.01	20.25	197	.29	.29	.00	107.
1.01	4.29	54	.01	.03	.01	1.	1.01	20.30	198	.29	.29	.00	106.
1.01	4.30	55	.01	.03	.01	1.	1.01	20.35	199	.29	.29	.00	106.
1.01	4.31	56	.01	.03	.01	1.	1.01	20.40	200	.29	.29	.00	106.
1.01	4.33	57	.01	.03	.01	1.	1.01	20.45	201	.29	.29	.00	106.
1.01	4.34	58	.01	.03	.01	1.	1.01	20.50	202	.29	.29	.00	106.
1.01	4.35	59	.01	.03	.01	1.	1.01	20.55	203	.29	.29	.00	106.
1.01	5.01	60	.01	.03	.01	1.	1.01	21.00	204	.29	.29	.00	106.
1.01	5.05	61	.01	.03	.01	1.	1.01	21.05	205	.23	.23	.00	94.
1.01	5.07	62	.01	.03	.01	1.	1.01	21.10	206	.23	.23	.00	89.
1.01	5.09	63	.01	.03	.01	1.	1.01	21.15	207	.23	.23	.00	86.
1.01	5.11	64	.01	.03	.01	2.	1.01	21.20	208	.23	.23	.00	84.
1.01	5.13	65	.01	.03	.01	2.	1.01	21.25	209	.23	.23	.00	84.
1.01	5.15	66	.01	.03	.01	2.	1.01	21.30	210	.23	.23	.00	84.
1.01	5.17	67	.01	.03	.01	2.	1.01	21.35	211	.23	.23	.00	84.
1.01	5.19	68	.01	.03	.01	2.	1.01	21.40	212	.23	.23	.00	84.
1.01	5.21	69	.01	.03	.01	2.	1.01	21.45	213	.23	.23	.00	84.
1.01	5.23	70	.01	.03	.01	2.	1.01	21.50	214	.23	.23	.00	84.
1.01	5.25	71	.01	.03	.01	2.	1.01	21.55	215	.23	.23	.00	84.

							1.01	17.15	211	.23	.23	.00	84.
							1.01	17.40	212	.23	.23	.00	84.
							1.01	17.45	213	.23	.23	.00	84.
							1.01	17.50	214	.23	.23	.00	84.
							1.01	17.55	215	.23	.23	.00	84.
							1.01	18.00	216	.23	.23	.00	84.
							1.01	18.05	217	.02	.02	.00	56.
							1.01	18.10	218	.02	.02	.00	27.
							1.01	18.15	219	.02	.02	.00	14.
							1.01	18.20	220	.02	.02	.00	10.
							1.01	18.25	221	.02	.02	.00	9.
							1.01	18.30	222	.02	.02	.00	8.
							1.01	18.35	223	.02	.02	.00	8.
							1.01	18.40	224	.02	.02	.00	8.
							1.01	18.45	225	.02	.02	.00	8.
							1.01	18.50	226	.02	.02	.00	8.
							1.01	18.55	227	.02	.02	.00	8.
							1.01	19.00	228	.02	.02	.00	8.
							1.01	19.05	229	.02	.02	.00	8.
							1.01	19.10	230	.02	.02	.00	8.
							1.01	19.15	231	.02	.02	.00	8.
							1.01	19.20	232	.02	.02	.00	8.
							1.01	19.25	233	.02	.02	.00	8.
							1.01	19.30	234	.02	.02	.00	8.
							1.01	19.35	235	.02	.02	.00	8.
							1.01	19.40	236	.02	.02	.00	8.
							1.01	19.45	237	.02	.02	.00	8.
							1.01	19.50	238	.02	.02	.00	8.
							1.01	19.55	239	.02	.02	.00	8.
							1.01	20.00	240	.02	.02	.00	8.
							1.01	20.05	241	.02	.02	.00	8.
							1.01	20.10	242	.02	.02	.00	8.
							1.01	20.15	243	.02	.02	.00	8.
							1.01	20.20	244	.02	.02	.00	8.
							1.01	20.25	245	.02	.02	.00	8.
							1.01	20.30	246	.02	.02	.00	8.
							1.01	20.35	247	.02	.02	.00	8.
							1.01	20.40	248	.02	.02	.00	8.
							1.01	20.45	249	.02	.02	.00	8.
							1.01	20.50	250	.02	.02	.00	8.
							1.01	20.55	251	.02	.02	.00	8.
							1.01	21.00	252	.02	.02	.00	8.
							1.01	21.05	253	.02	.02	.00	8.
							1.01	21.10	254	.02	.02	.00	8.
							1.01	21.15	255	.02	.02	.00	8.
							1.01	21.20	256	.02	.02	.00	8.
							1.01	21.25	257	.02	.02	.00	8.
							1.01	21.30	258	.02	.02	.00	8.
							1.01	21.35	259	.02	.02	.00	8.
							1.01	21.40	260	.02	.02	.00	8.
							1.01	21.45	261	.02	.02	.00	8.
							1.01	21.50	262	.02	.02	.00	8.
							1.01	21.55	263	.02	.02	.00	8.
							1.01	22.00	264	.02	.02	.00	8.
							1.01	22.05	265	.02	.02	.00	8.
							1.01	22.10	266	.02	.02	.00	8.
							1.01	22.15	267	.02	.02	.00	8.
							1.01	22.20	268	.02	.02	.00	8.
							1.01	22.25	269	.02	.02	.00	8.
							1.01	22.30	270	.02	.02	.00	8.
							1.01	22.35	271	.02	.02	.00	8.

1.01	17.45	121	.07	.06	.01	21.	1.01	22.43	272	.02	.02	.00	8.
1.01	17.50	122	.07	.06	.01	21.	1.01	22.45	273	.02	.02	.00	8.
1.01	17.55	123	.07	.06	.01	21.	1.01	22.50	274	.02	.02	.00	8.
1.01	17.60	124	.07	.06	.01	21.	1.01	22.55	275	.02	.02	.00	8.
1.01	17.65	125	.07	.06	.01	21.	1.01	23.00	276	.02	.02	.00	8.
1.01	17.70	126	.07	.06	.01	21.	1.01	23.05	277	.02	.02	.00	8.
1.01	17.75	127	.07	.06	.01	21.	1.01	23.10	278	.02	.02	.00	8.
1.01	17.80	128	.07	.06	.01	21.	1.01	23.15	279	.02	.02	.00	8.
1.01	17.85	129	.07	.06	.01	21.	1.01	23.20	280	.02	.02	.00	8.
1.01	17.90	130	.07	.06	.01	22.	1.01	23.25	281	.02	.02	.00	8.
1.01	17.95	131	.07	.06	.01	22.	1.01	23.30	282	.02	.02	.00	8.
1.01	18.00	132	.07	.06	.01	22.	1.01	23.35	283	.02	.02	.00	8.
1.01	18.05	133	.07	.06	.01	22.	1.01	23.40	284	.02	.02	.00	8.
1.01	18.10	134	.07	.06	.01	22.	1.01	23.45	285	.02	.02	.00	8.
1.01	18.15	135	.07	.06	.01	22.	1.01	23.50	286	.02	.02	.00	8.
1.01	18.20	136	.07	.06	.01	22.	1.01	23.55	287	.02	.02	.00	8.
1.01	18.25	137	.07	.06	.01	22.	1.02	.00	288	.02	.02	.00	8.

SUM 72.50 30.01 2.49 10917.
(825.)(762.)(63.)(309.13)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	844.	124.	36.	36.	10681.
CMS	18.	4.	1.	1.	302.
INCHES		24.60	29.97	29.97	29.97
MM		624.95	761.35	761.35	761.35
AC-FT		62.	75.	75.	75.
THOUS CU M		76.	92.	92.	92.

HYDROGRAPH AT STA 2 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	46.	12.	4.	4.	1068.
CMS	2.	0.	0.	0.	31.
INCHES		2.46	3.00	3.00	3.00
MM		62.50	76.13	76.13	76.13
AC-FT		6.	7.	7.	7.
THOUS CU M		8.	9.	9.	9.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	97.	19.	6.	6.	1632.
CMS	3.	1.	0.	0.	46.
INCHES		3.69	4.50	4.50	4.50
MM		93.74	114.20	114.20	114.20
AC-FT		9.	11.	11.	11.
THOUS CU M		11.	14.	14.	14.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 3

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SUM OF 3 HYDROGRAPHS AT        - PLAN 1  RTIO 9

              PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
    CFS      [illegible]  2[illegible]3.  79.   79.   22790.
    CMS       [illegible]     7.       2.        2.        645.
 INCHES              25.[illegible]   30.77     30.77      30.77
     MM             649.19    781.51    781.51     781.51
  AC-FT              1[illegible].      1[illegible].      157.       157.
THOUS CU M           1[illegible]1.     194.      194.       194.

**********      **********      **********      **********      **********

                         HYDROGRAPH ROUTING

     ROUTE HYDROGRAPH THROUGH LOWER DAM

       ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT   INAME  ISTAGE   IAUTO
         5       1       0       0       0      0      1       0       0
                              ROUTING DATA
 QLOSS   CLOSS    AVG    IRES   ISAME   IOPT   IPMP            LSTR
   .0    [illegible]     .00      1       1      0      0               0

[illegible]                                          PROJECT 09457    DATE 30 DEC 80   PAGE  59
**********************************************************************************************
[illegible]                                          PROGRAM H21/02-1V  TIME  16:26:18  CASE PMF

       NSTPS   NSTDL    LAG   AMSKK     X      TSK   STORA  ISPRAT
         1       0       0    .000    .000    .000   -909.    -1

STAGE  [illegible]  [illegible]  911.70  912.00  914.00  914.00  918.00  920.00
FLOW   [illegible]  [illegible]  31.70   38.00   60.00   75.00   86.00   96.00
SURFACE AREA=  [illegible]  4.  4.  4.  [illegible]  [illegible]
CAPACITY=  [illegible]  [illegible]  34.  43.  63.  [illegible]
ELEVATION=  [illegible]  [illegible]  910.  912.  916.  920.

   CREL   SPWID   COQW   EXPW   ELEVL   COOL   CAREA   EXPL
 [illegible]     .0      .0     .0      .0      .0     .0      .0

                     DAM DATA
              TOPEL   COQD   EXPD   DAMWID
              911.[illegible]     .0     .0      0.

CREST LENGTH  [illegible]  [illegible]  137.  209.  239.  271.  30[illegible].
AT OR BELOW
ELEVATION     [illegible]  [illegible]  912.9  912.6  913.0  913  914.2

               STATION   5, PLAN 1, RAT. 1

             END-OF-PERIOD HYDROGRAPH ORDINATES

                        OUTFLOW
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Upper Dam

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	922.30	922.30	925.50
STORAGE	[illegible]	4.	9.
OUTFLOW	[illegible]	0.	13.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	[illegible]	[illegible]	8.	11.	.00	17.0?	.60
.15	926.0?	.3?	9.	210.	.?3	16.49	15.?3
[illegible]	927.0?	.79	10.	23?.	.42	16.17	15.58
[illegible]	92?.76	.26	9.	?20.	.48	15.?1	15.25
[illegible]	92?.69	.19	9.	229.	.?3	15.27	14.58
[illegible]	926.73	.??	9.	237.	.35	14.87	14.17
.40	92?.6?	.1?	9.	270.	.33	15.67	13.75
.50	925.79	.29	9.	336.	.37	15.67	13.25
1.00	926.5?	.0?	9.	659.	.25	15.67	11.42

SUMMARY OF DAM SAFETY ANALYSIS

Lower Dam
SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	899.00	909.00	911.00
STORAGE	0.	30.	40.
OUTFLOW	0.	0.	90.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE ACRE-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.00	909.00	.00	35.	17.	.00	15.00	.00
.05	909.29	.29	43.	174.	2.00	15.07	.00
.10	909.61	.61	51.	237.	2.00	15.17	.00
.15	909.91	.91	58.	293.	2.00	15.92	.00
.20	910.09	1.09	64.	326.	2.00	15.67	.00
.25	910.22	1.22	66.	376.	2.00	15.67	.00
.30	910.45	1.45	69.	393.	4.00	15.75	.00
.40	910.73	1.73	75.	452.	4.58	15.75	.00
.50	910.94	1.94	80.	471.	5.17	15.75	.00
1.00	911.00	2.00	85.	1195.	7.25	15.67	.00

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SEQ # CTS # 1234567890123456789012345678901234567890123456789012345678901234567890123456789

   1     * H21 02-1 09457      100 YR
   2     A1                MISSOURI DAM INSPECTION PROGRAM
   3     A2           ST. LOUIS DISTRICT US ARMY CORPS OF ENGR.
   4     A3                     UNION LAKE DAM - 100 YR
   5     B    288             5                                           1
   6     B1     1
   7     K             1                                     1
   8     K1   UNION LAKE INFLOW HYDROGRAPH FOR UPPER DAM
   9     M      0        20.0488                             1.
  10     O    288   7.594                      DA #     .50
  11     01  .004    .006    .006    .004    .006    .006    .004    .006    .006    .004
  12     01  .004    .006    .006    .004    .006    .006    .004    .006    .006    .004
  13     01  .006    .006    .006    .006    .006    .005    .004    .006    .006    .006
  14     01  .006    .006    .006    .006    .006    .004    .004    .004    .006    .004
  15     01  .004    .006    .006    .006    .006    .006    .006    .006    .006    .004
  16     01  .006    .006    .006    .006    .004    .006    .004    .004    .004    .004
  17     01  .006    .006    .004    .006    .004    .005    .006    .006    .006    .004
  18     01  .006    .006    .015    .015    .015    .015    .015    .015    .015    .015
  19     01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
  20     01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
  21     01  .015    .015    .015    .015    .015    .015    .015    .015    .029    .029
  22     01  .028    .028    .028    .028    .028    .024    .028    .028    .028    .028
  23     01  .028    .028    .028    .028    .028    .028    .029    .029    .029    .029
  24     01  .029    .029    .065    .065    .065    .065    .065    .065    .152    .152
  25     01  .152    .291    .291    .575    .546    .403    .291    .153    .152    .152
  26     01  .065    .065    .065    .065    .065    .065    .029    .029    .029    .029
  27     01  .029    .028    .028    .028    .028    .023    .028    .028    .028    .028
  28     01  .028    .028    .028    .028    .028    .024    .028    .029    .028    .028
  29     01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
  30     01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
  31     01  .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
  32     01  .015    .015    .015    .015    .015    .015    .006    .006    .006    .004
  33     01  .006    .006    .006    .006    .006    .006    .005    .006    .006    .004
  34     01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
  35     01  .006    .006    .006    .006    .006    .006    .004    .006    .006    .006
  36     01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .004
  37     01  .006    .006    .006    .006    .004    .005    .004    .006    .006    .006
  38     01  .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
  39     01  .006    .006    .006    .006    .006    .006    .005    .006
  40     T                                                    -1     -65
  41     W2       0.0PS
  42     X               1.
  43     K      1        2                                   1
  44     K1   ROUTED HYDROGRAPH THROUGH UPPER DAM
  45     Y                                1        1
  46     Y1     1                                        -922.3       -1
  47     Y4922.3 924.0   927.0   929.0   931.0   931.3
  48     Y50.0   6.8     14.5    18.0    20.0    20.8
  49     SA0.0   1.24    1.18    1.26    1.49    2.25    3.05
  50     SE910.3 922.3   924.3   926.3   928.3   932.3   936.3
```

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          0000000001111111111222222222233333333334444444444555555555566666666667777777777
SEQ #  CDS # 1234567890123456789012345678901234567890123456789012345678901234567890123456789

   51        $$922.3
   52        $$976.5
   53        $10.0    59.0     157.0    195.0    225.0    274.0
   54        $$5906.5 927.0    928.0    925.0    930.0    931.0
   55        $$10.0   0.5      927.5    1.0      922.3    926.5
   56        K                 1                                          1
   57        K1   HYDROGRAPH FROM UNCONTROLLED DA UPSTREAM OF LOWER DAM
   58        M         0          20.0462                          1.0
   59        P     228    7.594                    TR #       .50
   60        O1   .004     .004     .004     .005     .004     .006     .006     .006     .006     .006
   61        O1   .006     .006     .004     .004     .004     .006     .006     .006     .006     .006
   62        O1   .004     .004     .004     .004     .006     .006     .006     .006     .006     .006
   63        O1   .004     .006     .006     .004     .004     .004     .006     .004     .006     .006
   64        O1   .004     .004     .004     .004     .006     .006     .006     .006     .006     .006
   65        O1   .005     .004     .004     .004     .006     .006     .005     .006     .006     .004
   66        O1   .004     .004     .004     .004     .004     .006     .004     .006     .006     .006
   67        O1   .014     .014     .015     .015     .015     .015     .015     .015     .015     .015
   68        O1   .015     .015     .015     .015     .015     .015     .015     .015     .015     .015
   69        O1   .015     .015     .015     .015     .015     .015     .015     .015     .015     .015
   70        O1   .015     .015     .015     .015     .015     .015     .015     .015     .028     .028
   71        O1   .028     .028     .028     .028     .028     .028     .028     .028     .028     .028
   72        O1   .028     .028     .028     .028     .028     .028     .029     .029     .029     .029
   73        O1   .029     .029     .065     .065     .065     .065     .065     .065     .152     .152
   74        O1   .153     .291     .293     .378     .544     .400     .291     .153     .153     .152
   75        O1   .065     .065     .065     .065     .065     .065     .029     .029     .029     .029
   76        O1   .029     .029     .028     .028     .028     .028     .029     .028     .028     .028
   77        O1   .028     .028     .028     .028     .028     .028     .028     .028     .028     .028
   78        O1   .015     .015     .015     .015     .015     .015     .015     .015     .015     .015
   79        O1   .015     .015     .015     .015     .015     .015     .015     .015     .015     .015
   80        O1   .015     .015     .015     .015     .015     .015     .015     .015     .015     .015
   81        O1   .015     .015     .015     .015     .015     .015     .006     .006     .006     .006
   82        O1   .006     .006     .006     .006     .006     .006     .006     .006     .006     .006
   83        O1   .004     .004     .004     .004     .004     .004     .005     .006     .004     .004
   84        O1   .004     .004     .004     .004     .006     .004     .004     .006     .004     .006
   85        O1   .004     .004     .004     .004     .006     .006     .005     .004     .006     .006
   86        O1   .005     .005     .004     .004     .006     .006     .004     .005     .005     .006
   87        O1   .006     .004     .004     .004     .006     .004     .006     .006     .004     .006
   88        O1   .004     .004     .004     .004     .004     .004     .004     .004
   89        T                                                         -1       -.05
   90        [illegible]     0.091
   91        X                 1.0
   92        K         2        4                                      1
   93        K1   COMBINE INFLOW AND OUTFLOW FROM UPPER DAM
   94        K         1        5                                      1
   95        K1   ROUTE HYDROGRAPH THROUGH LOWER DAM
   96        Y                                      1        1
   97        Y1        1                                          -200.2        -1
   98        Y4909.2  910.3    911.7    912.0    914.0    916.0    918.     920.
   99        Y5   0.0  17.5    27.7     39.0     60.0     77.0     86.0     96.0
  100        $$0.0    4.01     4.24     4.44     5.39     6.74
```

```
LISTING OF INPUT DATA                             DATE 02 JAN 81   TIME 09:10:2?

              0000000000111111111122222222223333333333444444444455555555556666666666777777777?
SEQ #  CTS #  123456789012345678901234567890123456789012345678901234567890123456789012345678?

  101         $FB98.8 908.3   910.3   912.3   916.3   920.3
  102         $1909.2
  103         $0911.6
  104         $LO.0   63.0    137.0   208.0   238.0   271.0   303.0
  105         $V911.6 911.8   912.1   912.6   913.0   913.5   914.2
  106         A       99
  107         A
  108         A
  109         A
  110         A
  111         A

@ASG,A SYSLIB*ADD.
FAC WARNING       040200104000

@ASG,A SYSLIB*UG7.
FAC WARNING       040200104200

@ASG,A SYSLIB*H21.
FAC WARNING       040200004000

@ASG,T 2.

@ASG,T 3.

@ASG,T 4.

@ASG,T 7.

@ASG,T 10.

@ASG,T 11.

@ASG,T 17.

@ASG,T 14.

@ASG,T 15.

@XQT SYSLIB*UG7.UG7

@XQT,V SYSLIB*H21.H21/02-1
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B L A C K   &   V E A T C H                                                                    PROJECT 5457      DATE 02 JAN 81   PAGE
*********************************************************************************************************************************
FLOOD HYDROGRAPH PACKAGE - HEC-1                                                                PROGRAM M21/P2-1V  TIME 09:10:49  CASE

********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  21 APR 80
********************************

                         MISSOURI DAM INSPECTION PROGRAM
                    ST. LOUIS DISTRICT US ARMY CORPS OF ENGR.
                            UNION LAKE DAM - 100 YR

                                          JOB SPECIFICATION
              NQ       NHR      NMIN      IDAY      IHR      IMIN    METRC     IPLT     IPRT    NSTAN
             288         0         5         0        0         0        0        0        0        0
                                         JOPER      NWT     LROPT    TRACE
                                             5        0         0        0

          **********          **********          **********          **********          **********

                                    SUB-AREA RUNOFF COMPUTATION

                  UNION LAKE INFLOW HYDROGRAPH FOR UPPER DAM

                          ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE   IAUTO
                              1        0        0        0        0        0        1        0       0

                                          HYDROGRAPH DATA
              IHYDG      IUHG     TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
                  2         2       .05      .00      .05     1.00     .000        0        0        0

                                            PRECIP DATA
                                      NP   STORM      DAJ      DAK
                                     288    7.55      .00      .00
                                          PRECIP PATTERN
      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
      .01       .01       .01       .01       .01       .01       .01       .01       .01       .01
      .01       .01       .02       .02       .02       .02       .02       .02       .02       .02
      .02       .02       .02       .02       .02       .02       .02       .02       .02       .02
      .02       .02       .02       .02       .02       .02       .02       .02       .02       .02
      .02       .02       .02       .02       .02       .02       .02       .02       .03       .03
      .03       .03       .03       .03       .03       .03       .03       .03       .03       .03
      .03       .03       .03       .03       .03       .03       .03       .03       .03       .03
      .03       .03       .07       .07       .07       .07       .07       .07       .15       .15
      .15   [illegible]   .29   [illegible]   .15       .40       .29       .15       .15       .15
      .07       .07       .07       .07       .07       .07       .03       .03       .03       .03
      .03       .03       .03       .03       .03       .03       .03       .03       .03       .03
      .03       .03       .03       .03       .03       .03       .03       .03       .03       .03
      .02       .02       .02       .02       .02       .02       .02       .02       .02       .02
      .02       .02       .02       .02       .02       .02       .02       .02       .02       .02
      .02       .02       .02       .02       .02       .02       .02       .02       .02       .02
      .02       .02       .02       .02       .02       .02       .01       .01       .01       .01
```

.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01		

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	.00	.00	1.00	.00	.00	1.00	-1.00	-65.00	.00	.00

CURVE NO = -65.00 WETNESS = -1.00 EFFECT CN = 65.00

UNIT HYDROGRAPH DATA
TC= .00 LAG= .08

RECESSION DATA
STRTQ= .00 QRCSN= .00 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 7 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= .08 VOL= 1.00
139. 156. 54. 19. 6. 2. 1.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.05	145	.84	.49	.35	172.
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.40	.25	.14	170.
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.29	.19	.10	94.
1.01	.20	4	.01	.00	.01	0.	1.01	12.20	148	.15	.10	.05	74.
1.01	.25	5	.01	.00	.01	0.	1.01	12.25	149	.15	.10	.05	49.
1.01	.30	6	.01	.00	.01	0.	1.01	12.30	150	.15	.10	.05	43.
1.01	.35	7	.01	.00	.01	0.	1.01	12.35	151	.06	.05	.02	32.
1.01	.40	8	.01	.00	.01	0.	1.01	12.40	152	.06	.05	.02	24.
1.01	.45	9	.01	.00	.01	0.	1.01	12.45	153	.06	.05	.02	19.
1.01	.50	10	.01	.00	.01	0.	1.01	12.50	154	.06	.05	.02	16.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.06	.05	.02	15.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.06	.05	.02	15.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.03	.02	.01	14.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.03	.02	.01	12.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.03	.02	.01	9.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.03	.02	.01	[illegible]
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.03	.02	.01	8.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.03	.02	.01	8.
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.03	.02	.01	8.
1.01	1.40	20	.01	.00	.01	0.	1.01	13.40	164	.03	.02	.01	8.
1.01	1.45	21	.01	.00	.01	0.	1.01	13.45	165	.03	.02	.01	8.
1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.03	.02	.01	8.
1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.03	.02	.01	[illegible]
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.03	.02	.01	8.
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.03	.02	.01	8.
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.03	.02	.01	8.
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.03	.02	.01	8.
1.01	2.20	28	.01	.00	.01	0.	1.01	14.20	172	.03	.02	.01	[illegible]

1.01 2.25 29 .01 .00 .01 ... 1.01 14.25 173 ...

[illegible]	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.01	.02	.01	8.
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.01	.02	.01	9.
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.01	.02	.01	8.
1.01	2.20	28	.01	.00	.01	0.	1.01	14.20	172	.01	.02	.01	8.

B L A C K & V E A T C H PROJECT 09457 DATE 02 JAN 81 PAGE 5

FLOOD HYDROGRAPH PACKAGE - HEC-1 PROGRAM H21/02-1V TIME 09:10:49 CASE 100 YR

1.01	2.25	29	.01	.00	.01	0.	1.01	14.25	173	.01	.02	.01	8.
1.01	2.30	30	.01	.00	.01	0.	1.01	14.30	174	.01	.02	.01	8.
1.01	2.35	31	.01	.00	.01	0.	1.01	14.35	175	.01	.02	.01	8.
1.01	2.40	32	.01	.00	.01	0.	1.01	14.40	176	.01	.02	.01	8.
1.01	2.45	33	.01	.00	.01	0.	1.01	14.45	177	.01	.02	.01	9.
1.01	2.50	34	.01	.00	.01	0.	1.01	14.50	178	.01	.02	.01	9.
1.01	2.55	35	.01	.00	.01	0.	1.01	14.55	179	.01	.02	.01	8.
1.01	3.00	36	.01	.00	.01	0.	1.01	15.00	180	.01	.02	.01	8.
1.01	3.05	37	.01	.00	.01	0.	1.01	15.05	181	.01	.01	.00	7.
1.01	3.10	38	.01	.00	.01	0.	1.01	15.10	182	.01	.01	.00	5.
1.01	3.15	39	.01	.00	.01	0.	1.01	15.15	183	.01	.01	.00	5.
1.01	3.20	40	.01	.00	.01	0.	1.01	15.20	184	.01	.01	.00	4.
1.01	3.25	41	.01	.00	.01	0.	1.01	15.25	185	.01	.01	.00	4.
1.01	3.30	42	.01	.00	.01	0.	1.01	15.30	186	.01	.01	.00	4.
1.01	3.35	43	.01	.00	.01	0.	1.01	15.35	187	.01	.01	.00	4.
1.01	3.40	44	.01	.00	.01	0.	1.01	15.40	188	.01	.01	.00	4.
1.01	3.45	45	.01	.00	.01	0.	1.01	15.45	189	.01	.01	.00	4.
1.01	3.50	46	.01	.00	.01	0.	1.01	15.50	190	.01	.01	.00	4.
1.01	3.55	47	.01	.00	.01	0.	1.01	15.55	191	.01	.01	.00	4.
1.01	4.00	48	.01	.00	.01	0.	1.01	16.00	192	.01	.01	.00	4.
1.01	4.05	49	.01	.00	.01	0.	1.01	16.05	193	.01	.01	.00	4.
1.01	4.10	50	.01	.00	.01	0.	1.01	16.10	194	.01	.01	.00	4.
1.01	4.15	51	.01	.00	.01	0.	1.01	16.15	195	.01	.01	.00	4.
1.01	4.20	52	.01	.00	.01	0.	1.01	16.20	196	.01	.01	.00	4.
1.01	4.25	53	.01	.00	.01	0.	1.01	16.25	197	.01	.01	.00	4.
1.01	4.30	54	.01	.00	.01	0.	1.01	16.30	198	.01	.01	.00	4.
1.01	4.35	55	.01	.00	.01	0.	1.01	16.35	199	.01	.01	.00	4.
1.01	4.40	56	.01	.00	.01	0.	1.01	16.40	200	.01	.01	.00	4.
1.01	4.45	57	.01	.00	.01	0.	1.01	16.45	201	.01	.01	.00	4.
1.01	4.50	58	.01	.00	.01	0.	1.01	16.50	202	.01	.01	.00	4.
1.01	4.55	59	.01	.00	.01	0.	1.01	16.55	203	.01	.01	.00	4.
1.01	5.00	60	.01	.00	.01	0.	1.01	17.00	204	.01	.01	.00	4.
1.01	5.05	61	.01	.00	.01	0.	1.01	17.05	205	.01	.01	.00	4.
1.01	5.10	62	.01	.00	.01	0.	1.01	17.10	206	.01	.01	.00	4.
1.01	5.15	63	.01	.00	.01	0.	1.01	17.15	207	.01	.01	.00	4.
1.01	5.20	64	.01	.00	.01	0.	1.01	17.20	208	.01	.01	.00	4.
1.01	5.25	65	.01	.00	.01	0.	1.01	17.25	209	.01	.01	.00	4.
1.01	5.30	66	.01	.00	.01	0.	1.01	17.30	210	.01	.01	.00	4.
1.01	5.35	67	.01	.00	.01	0.	1.01	17.35	211	.01	.01	.00	4.
1.01	5.40	68	.01	.00	.01	0.	1.01	17.40	212	.01	.01	.00	4.
1.01	5.45	69	.01	.00	.01	0.	1.01	17.45	213	.01	.01	.00	4.
1.01	5.50	70	.01	.00	.01	0.	1.01	17.50	214	.01	.01	.00	4.
1.01	5.55	71	.01	.00	.01	0.	1.01	17.55	215	.01	.01	.00	4.
1.01	6.00	72	.01	.00	.01	0.	1.01	18.00	216	.01	.01	.00	4.
1.01	6.05	73	.01	.00	.01	0.	1.01	18.05	217	.01	.00	.00	3.
1.01	6.10	74	.01	.00	.01	0.	1.01	18.10	218	.01	.00	.00	2.
1.01	6.15	75	.01	.00	.01	0.	1.01	18.15	219	.01	.00	.00	2.
1.01	6.20	76	.01	.00	.01	0.	1.01	18.20	220	.01	.00	.00	2.
1.01	6.25	77	.01	.00	.01	0.	1.01	18.25	221	.01	.00	.00	2.
1.01	6.30	78	.01	.00	.01	0.	1.01	18.30	222	.01	.00	.00	2.
1.01	6.35	79	.01	.00	.01	0.	1.01	18.35	223	.01	.00	.00	2.
1.01	6.40	80	.01	.00	.01	0.	1.01	18.40	224	.01	.00	.00	2.
1.01	6.45	81	.01	.00	.01	0.	1.01	18.45	225	.01	.00	.00	2.
1.01	6.50	82	.01	.00	.01	0.	1.01	18.50	226	.01	.00	.00	2.
1.01	6.55	83	.01	.00	.01	0.	1.01	18.55	227	.01	.00	.00	2.
1.01	7.00	84	.01	.00	.01	0.	1.01	19.00	228	.01	.00	.00	2.

1.01	7.05	85	.01	.00	.01	0.	1.01	19.05	229	.01	.00	.01	2.
1.01	7.10	86	.01	.00	.01	0.	1.01	19.10	230	.01	.00	.01	2.
1.01	7.15	87	.01	.00	.01	0.	1.01	19.15	231	.01	.00	.01	2.
1.01	7.20	88	.01	.00	.01	0.	1.01	19.20	232	.01	.00	.01	2.
1.01	7.25	89	.01	.00	.01	0.	1.01	19.25	233	.01	.00	.01	2.
1.01	7.30	90	.01	.00	.01	0.	1.01	19.30	234	.01	.00	.01	2.
1.01	7.35	91	.01	.00	.01	0.	1.01	19.35	235	.01	.00	.01	2.
1.01	7.40	92	.01	.00	.01	0.	1.01	19.40	236	.01	.00	.01	2.
1.01	7.45	93	.01	.00	.01	0.	1.01	19.45	237	.01	.00	.01	2.
1.01	7.50	94	.01	.00	.01	0.	1.01	19.50	238	.01	.00	.01	2.
1.01	7.55	95	.01	.00	.01	0.	1.01	19.55	239	.01	.00	.01	2.
1.01	8.00	96	.01	.00	.01	0.	1.01	20.00	240	.01	.00	.01	2.
1.01	8.05	97	.01	.00	.01	0.	1.01	20.05	241	.01	.00	.01	2.
1.01	8.10	98	.01	.00	.01	0.	1.01	20.10	242	.01	.00	.01	2.
1.01	8.15	99	.01	.00	.01	0.	1.01	20.15	243	.01	.00	.01	2.
1.01	8.20	100	.01	.00	.01	0.	1.01	20.20	244	.01	.00	.01	2.
1.01	8.25	101	.01	.00	.01	0.	1.01	20.25	245	.01	.00	.01	2.
1.01	8.30	102	.01	.00	.01	0.	1.01	20.30	246	.01	.00	.01	2.
1.01	8.35	103	.01	.00	.01	0.	1.01	20.35	247	.01	.00	.01	2.
1.01	8.40	104	.01	.00	.01	0.	1.01	20.40	248	.01	.00	.01	2.
1.01	8.45	105	.01	.00	.01	0.	1.01	20.45	249	.01	.00	.01	2.
1.01	8.50	106	.01	.00	.01	0.	1.01	20.50	250	.01	.00	.01	2.
1.01	8.55	107	.01	.00	.01	0.	1.01	20.55	251	.01	.00	.01	2.
1.01	9.00	108	.01	.00	.01	0.	1.01	21.00	252	.01	.00	.01	2.
1.01	9.05	109	.03	.00	.03	0.	1.01	21.05	253	.01	.00	.01	2.
1.01	9.10	110	.03	.00	.03	0.	1.01	21.10	254	.01	.00	.01	2.
1.01	9.15	111	.03	.00	.03	0.	1.01	21.15	255	.01	.00	.01	2.
1.01	9.20	112	.03	.00	.03	0.	1.01	21.20	256	.01	.00	.01	2.
1.01	9.25	113	.03	.00	.03	0.	1.01	21.25	257	.01	.00	.01	2.
1.01	9.30	114	.03	.00	.03	0.	1.01	21.30	258	.01	.00	.01	2.
1.01	9.35	115	.03	.00	.03	0.	1.01	21.35	259	.01	.00	.01	2.
1.01	9.40	116	.03	.00	.03	0.	1.01	21.40	260	.01	.00	.01	2.
1.01	9.45	117	.03	.00	.03	0.	1.01	21.45	261	.01	.00	.01	2.
1.01	9.50	118	.03	.00	.03	0.	1.01	21.50	262	.01	.00	.01	2.
1.01	9.55	119	.03	.00	.03	1.	1.01	21.55	263	.01	.00	.01	2.
1.01	10.00	120	.03	.00	.03	1.	1.01	22.00	264	.01	.00	.01	2.
1.01	10.05	121	.03	.00	.03	1.	1.01	22.05	265	.01	.00	.01	2.
1.01	10.10	122	.03	.00	.03	1.	1.01	22.10	266	.01	.00	.01	2.
1.01	10.15	123	.03	.00	.02	1.	1.01	22.15	267	.01	.00	.01	2.
1.01	10.20	124	.03	.00	.02	1.	1.01	22.20	268	.01	.00	.01	2.
1.01	10.25	125	.03	.00	.02	1.	1.01	22.25	269	.01	.00	.01	2.
1.01	10.30	126	.03	.00	.02	1.	1.01	22.30	270	.01	.00	.01	2.
1.01	10.35	127	.03	.00	.02	1.	1.01	22.35	271	.01	.00	.01	2.
1.01	10.40	128	.03	.00	.02	1.	1.01	22.40	272	.01	.00	.01	2.
1.01	10.45	129	.03	.00	.02	2.	1.01	22.45	273	.01	.00	.01	2.
1.01	10.50	130	.03	.00	.02	2.	1.01	22.50	274	.01	.00	.01	2.
1.01	10.55	131	.03	.00	.02	2.	1.01	22.55	275	.01	.00	.01	2.
1.01	11.00	132	.03	.00	.02	2.	1.01	23.00	276	.01	.00	.01	2.
1.01	11.05	133	.06	.01	.05	3.	1.01	23.05	277	.01	.00	.01	2.
1.01	11.10	134	.06	.01	.05	4.	1.01	23.10	278	.01	.00	.01	2.
1.01	11.15	135	.06	.01	.05	5.	1.01	23.15	279	.01	.00	.01	2.
1.01	11.20	136	.06	.02	.05	5.	1.01	23.20	280	.01	.00	.01	2.
1.01	11.25	137	.06	.02	.05	6.	1.01	23.25	281	.01	.00	.01	2.
1.01	11.30	138	.06	.02	.05	6.	1.01	23.30	282	.01	.00	.01	2.
1.01	11.35	139	.15	.04	.11	10.	1.01	23.35	283	.01	.00	.01	2.
1.01	11.40	140	.15	.05	.10	15.	1.01	23.40	284	.01	.00	.01	2.

1.01 11.45 141 .15 .05 .11 [illegible]

```
 .01  11.[illegible]   1[illegible]   .[illegible]   .02   .[illegible]      6.      1.01  27.30   282   .01   .00   .00     2.
 .01  11.35   1[illegible]   .1[illegible]   .04   .11     10.      1.01  27.35   283   .01   .00   .00     2.
1.01  11.40   140   .13   .05   .10     15.      1.01  27.40   284   .01   .00   .00     2.
```



```
1.01  11.45   141   .15   .05   .10     12.      1.01  27.45   285   .01   .00   .00     2.
1.01  11.50   142   .20   .11   .17     28.      1.01  27.50   286   .01   .00   .00     2.
1.01  11.55   143   .27   .13   .16     39.      1.01  27.55   287   .01   .00   .00     2.
1.01  12.00   144   .57   .29   .28     67.      1.02    .00   288   .01   .00   .00     2.

                                                     SUM   7.59   3.57   4.07   135[illegible].
                                                         ( 193.)( 91.)( 102.)(  38.45)

               PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
       CFS     170.      76.       5.        5.        174[illegible].
       CMS       4.       0.       0.        0.          39.
    INCHES               3.04     3.56      3.56        3.56
        MM              77.24    90.47     90.47       90.47
     AC-FT                 8.       9.        9.          9.
 THOUS CU M               10.      11.       11.         11.

**********      **********      **********      **********      **********

                              HYDROGRAPH ROUTING

             ROUTED HYDROGRAPH THROUGH UPPER DAM

                   ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                       2       1       0       0       0       0       1       0       0
                                         ROUTING DATA
           QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP                   LSTR
              .0    .000     .00       1       1       0       0                      0

                   NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                       1       0       0    .000    .000    .000   -922.      -1

 STAGE      922.30    926.00    927.00    929.00    931.00    931.70

 FLOW          .00      4.50     14.50     19.00     20.00     20.70

 SURFACE AREA=     0.       1.       1.       1.       1.       2.       1.

    CAPACITY=      0.       4.       6.       9.      11.      19.      29.

   ELEVATION=    919.     922.     924.     926.     928.     932.     936.

                   CREL    SPWID    COQW    EXPW    ELEVL    COQL    CAREA     EXPL
                  972.3       .0      .0      .0       .0      .0       .0       .0

                                             DAM DATA
                                  TOPEL     COQD    EXPD   DAMWID
                                  976.5       .0      .0       0.

 CREST LENGTH        0.       58.      157.      169.      228.      256.
 AT OR BELOW
 ELEVATION        976.5     977.0     978.0     979.0     970.0     9[illegible]1.0
```

Upper Dam

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	522.00	522.00	526.50
STORAGE	0.	0.	0.
OUTFLOW	0.	0.	0.

RATIO OF PMF	PARIMLP RESERVOIR W.S.ELEV	PARIMLP DEPTH OVER DAM	PARIMLP STORAGE AC-FT	PARIMLP OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	526.51	.01	9.	19?.	.15	13.??	??.??

FLOOD HYDROGRAPH PACKAGE - HEC-1 PROGRAM H21/02-1V TIME 09:19:49 DATE [illegible]

Lower Dam

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ***********

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	665.00	665.00	677.00
STORAGE	70.	70.	60.
OUTFLOW	0.	0.	70.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	672.30	.40	42.	101.	1.33	14.00	.00

APPENDIX B

BORING LOGS

BORING LOG

LEGEND AND NOMENCLATURE

Items shown on boring logs refer to the following:

1. Depth - Depth below reference elevation, ground surface unless otherwise shown.

2. Sample - Types designated by letter

   D - Disturbed sample, obtained from auger cuttings or wash water for classification purposes only.

   S - Split-Spoon sample, obtained by driving 2-inch split-spoon to determine penetration resistance and allow classification.

   C - Liner tube sample, obtained by penetration of thick, wall sampler containing 2-inch diameter liner-tubes (California sampler).

   U - Undisturbed sample, obtained by penetration of minimum 3 inch diameter, thin-wall tube using an open or, where indicated, fixed-piston sampling head.

   Rec - Recovery is expressed as a ratio of the length recovered to the total length pushed or driven (in inches) i.e. $\frac{8}{12}$

   Resist - Resistance is designated as follows:

   P - Sample pushed in one continuous movement by hydraulic rig action, maximum hydraulic pressure shown where pertinent.

   $^{3}6_{9}$ - Numbers indicate blows per 6 inches of sampler penetration when driven by a 140-pound hammer falling freely 30 inches. The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of the split-spoon sampler, e.g. 15. Note that a blow count can be given for the California sampler, but this is not the Standard Penetration Resistance.

3. Description - Description of material according to the Unified Soil Classification: word description gives soil constituents, consistency or density, and other appropriate classification characteristics. Unified Soil Classification symbols are shown on the USC column. Geologic names, where appropriate, are shown under Special Notes. A solid line indicates stratigraphic change; a dashed line indicates approximate location of stratigraphic change.

4. Special Notes and Field Observations - Pertinent observations made by inspector during drilling including type of boring, free water level, water seepage, fluid loss, hole termination depth, etc.

5. Legend -

   CFA - Continuous flight auger
   ATD - At time of drilling
   AD - After drilling
   DWL - Drill water loss
   DWR - Drill water return

   ▼ Water depth at specified time after drilling

   ← Water entry depth at time

BORING LOG

SHEET 1 OF 2
PROJECT NO. K79-88
DATE 9-14-79
RIG CME 55
WATER ENTERS None Detected ATD

PROJECT NAME DAMS AND PONDS

B-1

PROJECT LOCATION 29th & Blue Ridge Cut Off
GEOLOGIST M. Robinette DRILLER R. Herber
SURFACE ELEVATION 244 ELEVATION DATUM City

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, dark brown, low plastic Silty CLAY	CL	Boring advanced with 4" diameter CFA
	D			Very stiff, dark brown, medium plastic CLAY		WC > PL
5						
10	D			Very stiff, dark brown, highly plastic CLAY	CH	
15						
	D			SHALE: very stiff to hard, olive to buff, highly plastic, weathered	SH	
	D			SHALE: very stiff to hard, maroon, highly plastic, weathered		
20				SHALE: very stiff to hard, olive to buff, highly plastic, clayey	SH	
				LIMESTONE: light gray to light brown, fine grained, crystalline, slightly weathered	LS	
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 6

BORING LOG

SHEET 2 OF 2

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-1

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST M. Robinette DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 244 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: LIMESTONE: Light gray to light brown, slightly weathered	LS	Bottom of boring 25.5'
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 7

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-2

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST M. Robinette DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 240 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, dark brown, low plastic Silty CLAY	CL	Boring advanced with 4" diameter CFA
				Very stiff, dark brown, highly plastic CLAY	CH	WC > PL
5						
10	D					
15						
	D			SHALE: very stiff to hard, olive to maroon, highly plastic	SH	
20				LIMESTONE: light gray to light brown, fine grained, crystalline, slightly weathered	LS	
25						Bottom of boring 22.5'

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 8

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-3

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST M. Robinette DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 236 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, dark brown, medium plastic Silty CLAY		Boring advanced with 4" diameter CFA
				Becoming medium brown	CL	
5	D					WC > PL
				Very stiff, medium brown, highly plastic CLAY	CH	
10	D					
15				LIMESTONE: light gray to light brown, fine-grained, crystalline, slightly weathered	LS	
20						Bottom of boring 18.0'

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 9

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-4

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST M. Robinette DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 231 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, dark brown to black, low plastic, Silty CLAY	CL	Boring advanced with 4" diameter CFA
				Stiff, medium brown, medium plastic Silty CLAY		WC > PL
5	D					
10				Very stiff, dark brown, highly plastic CLAY	CH	
	D					
15				LIMESTONE: light gray to light brown, fine grained, crystalline, weathered to slightly weathered	LS	
						Bottom of boring 17.0'
20						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 10

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-5

DATE 9-14-79

PROJECT LOCATION 29th & Blue Ridge Cut Off

RIG CME 55

GEOLOGIST M. Robinette DRILLER R. Herber

WATER ENTERS None Detected ATD

SURFACE ELEVATION 226 ELEVATION DATUM City

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, medium brown, highly plastic CLAY with trace of silt	CH	Boring advanced with 4" diameter CFA WC > PL
5	D					
10	D			Very stiff, dark brown, highly plastic CLAY with trace of silt		WC > PL
15				LIMESTONE: buff to red brown, medium grained, slightly to very weathered	LS	
	D			SHALE: very stiff to hard, mottled black and olive, highly plastic, clayey, weathered	SH	
20						Bottom of boring 19.0'

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 11

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-98

DATE 9-14-79

B-6

PROJECT LOCATION 29th & Blue Ridge Cut Off

RIG CME 55

GEOLOGIST M. Robinette DRILLER R. Herber

WATER ENTERS None Detected ATD

SURFACE ELEVATION 212 ELEVATION DATUM City

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0	D			Stiff, dark brown, highly plastic CLAY with trace of silt	CH	Boring advanced with 4" diameter CFA
5				LIMESTONE: highly weathered	LS	
	D			Stiff, dark brown, highly plastic CLAY with trace of silt	CH	
				SHALE: very stiff, olive and light brown highly plastic, clayey, weathered	SH	
10	D					
15	D			SHALE: hard, blue gray, highly plastic, slightly weathered to weathered		
	D			LIMESTONE: buff to brown, medium grained weathered	LS	
20	D			SHALE: hard, light gray, highly plastic, slightly weathered	SH	
	D			LIMESTONE	LS	Bottom of boring 23.0'
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 12

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-7

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 225 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0	D			Stiff, medium to light brown, low plastic Silty CLAY	CL	Boring advanced with 4" diameter CFA WC < PL
5						WC > PL
10	D			Stiff, medium brown, highly plastic CLAY	CH	
				LIMESTONE: gray to light brown, fine to medium grained, weathered	LS	
15				SHALE: hard, tan to light green, highly plastic, weathered	SH	
				SHALE: dark gray to black, highly plastic, slightly weathered		
20	D			SHALE: medium to light gray, highly plastic, slightly to unweathered, with trace calcareous zones		
25						Bottom of boring 24.0'

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 13

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

DATE 9-14-79

B-8

PROJECT LOCATION 29th & Blue Ridge Cut Off

RIG CME 55

GEOLOGIST G. K. Hess DRILLER R. Herber

WATER ENTERS None Detected ATD

SURFACE ELEVATION 223 ELEVATION DATUM City

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, medium brown, low to medium plastic Silty CLAY	CL	Boring advanced with 4" diameter CFA WC < PL
5	D					WC > PL
10				LIMESTONE: light gray to light brown, fine to medium grained, weathered Becoming slightly weathered	LS	
				SHALE: dark gray to black, highly plastic, slightly weathered	SH	
15						Bottom of boring 14.0'

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 14

BORING LOG

SHEET 1 OF 1

PROJECT NAME D&MS AND PONDS

PROJECT NO. K79-88

B-9

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 237 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff to very stiff, medium brown, medium to low plastic Silty CLAY	CL	Boring Advanced with 4" diameter CFA WC>PL
5	D					
10						
15				Stiff, medium brown, highly plastic CLAY with trace of silt	CH	
				LIMESTONE: light gray to light brown, fine to medium grained, weathered	LS	
20				SHALE: very stiff, medium brown, highly plastic, weathered	SH	Bottom of boring 19.0'

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 15

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-10

DATE 9-14-79

PROJECT LOCATION 29th & Blue Ridge Cut Off

RIG CME 55

GEOLOGIST G. K. Hess DRILLER R. Herber

WATER ENTERS None Detected ATD

SURFACE ELEVATION 244 ELEVATION DATUM City

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Stiff, medium brown, medium to low plastic Silty CLAY	CL	Boring advanced with 4" diameter CFA
	D					WC>PL
5						
	D					
10						
15						
	D			Stiff, medium brown, highly plastic CLAY	CH	
				SHALE: very stiff to hard, maroon to medium brown, highly plastic, weathered	SH	
20				Becoming tan		
	D					
				LIMESTONE: light gray to light brown, fine to medium grained, weathered to slightly weathered	LS	
25						Bottom of boring 24.0'

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 16

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-11

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER C. Meyer

RIG CME 55

SURFACE ELEVATION 206 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Very stiff, medium brown, highly plastic, CLAY FILL with limestone and shale fragments	F I L L	Boring advanced with 4" diameter CFA
	C	4/12	P	Becoming predominantly shale		WC > PL
5	C	7/12	P	Stiff, mottled dark brown, light brown and light green, highly plastic CLAY FILL with some silt and trace of shale fragments		
	C	4/12	P	Stiff, gray to light green, highly plastic CLAY with limestone cobble at 8'	CH	
10	C	7/12	P	Becoming stiff to very stiff		
	C	8/12	P	Very stiff, mottled gray and light brown, highly plastic CLAY with trace of silt		
15	C	4/6	P	Grading to highly plastic CLAY to weathered Clayey SHALE	CH | SH	
20				LIMESTONE: light gray to light brown, fine to medium grained, slightly weathered	LS	Bottom of boring 18.0'

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 17

BORING LOG

PROJECT NAME DAMS AND PONDS

SHEET 1 OF 2

PROJECT NO. K79-88

DATE 9-14-79

RIG CME 75

WATER ENTERS ▽ El 183 ATD

B-12

PROJECT LOCATION 29th & Blue Ridge Cut Off

GEOLOGIST G. K. Hess DRILLER C. Meyer

SURFACE ELEVATION 205± ELEVATION DATUM City

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Gravel Fill	FILL	Boring advanced with 4" diameter CFA
				Very stiff, dark brown, highly plastic CLAY FILL with trace limonite nodules and shale fragments		
	C	4/10	P			
5	C	8/12	P	With some low to medium plastic clay zones		
	U	12/12	P			
				Stiff, gray-green, highly plastic CLAY and SHALE FILL with silt		
	C	7/12	P			
10						
	U	10/12	P	Firm, mottled gray to light green, medium to highly plastic CLAY FILL with shale fragments		
15				Firm, mottled medium to dark brown, low plastic Silty CLAY	CL	
	U	12/12	P			
20				With occasional limestone fragments		
	U	12/12	P			
				SHALE: stiff to very stiff, medium gray, highly plastic, weathered	SH	← Water detected ATD
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 18

BORING LOG

SHEET 2 OF 2

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-12

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

RIG CME 75

GEOLOGIST G. K. Hess DRILLER C. Meyer

WATER ENTERS @ El 183 ATD

SURFACE ELEVATION 205± ELEVATION DATUM City

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: SHALE, hard, dark to medium gray, highly plastic, weathered	SH	
	C	5/5	P	Becoming slightly weathered		
30						
						Bottom of boring 32.0'
35						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 19

BORING LOG

SHEET 1 OF 1

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-13

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER C. Meyer

RIG CME 75

SURFACE ELEVATION 206 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Very stiff, medium brown, medium plastic, CLAY FILL with limestone and shale fragments	FILL	Boring advanced with 4" diameter CFA
	C	0/12	P			
				SHALE: stiff, mottled tan to light brown, highly plastic, very weathered	SH	
5	C	4/12	P			
				With brown layers		
	C	6/12	P			
				Becoming olive green		
10	C	4/12	P			
				Becoming mottled gray and yellow brown with limestone fragments		
	C	6/12	P			
15				Becoming gray and slightly weathered		
						Bottom of boring 17.0'
20						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 20

BORING LOG

SHEET 1 OF 2

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-14

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER C. Mayer

RIG CME 75

SURFACE ELEVATION 192 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Very stiff, medium brown, medium plastic gravel and CLAY FILL	FILL	Boring advanced with 4" diameter CFA
				Very stiff, medium brown, highly plastic, desiccated CLAY FILL		WC<PL
	C	4/12	P			
5	C	8/12	P	With some low plastic silty layers		WC>PL
	C	4/12	P			
10	C	8/12	P	Stiff, dark gray to dark brown, low plastic Silty CLAY with trace of organic matter	CL	
	C	6/12	P	Stiff, mottled medium brown to gray, highly plastic CLAY with some silt	CH	
15				SHALE: hard, tan, highly plastic, weathered	SH	
	C	4/8	P			
20				Becoming slightly weathered		
	C	4/4	P			
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 21

BORING LOG

SHEET 2 OF 2

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-14

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER C. Meyer

RIG CME 75

SURFACE ELEVATION 192 ELEVATION DATUM City

WATER ENTERS None detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
25				SAME: SHALE, hard, tan, highly plastic, slightly weathered	SH	
						Bottom of boring 27.0'
30						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 22

BORING LOG

SHEET 1 OF 2

PROJECT NAME DAMS AND PONDS

PROJECT NO. K79-88

B-15

PROJECT LOCATION 29th & Blue Ridge Cut Off

DATE 9-14-79

GEOLOGIST G. K. Hess DRILLER R. Herber

RIG CME 55

SURFACE ELEVATION 189 ELEVATION DATUM City

WATER ENTERS None Detected ATD

DEPTH	SAMPLE TYPE	SAMPLE REC	SAMPLE RESIST	DESCRIPTION	U.S.C.	SPECIAL NOTES AND FIELD OBSERVATIONS
0				Very stiff, medium to light brown, low plastic CLAY FILL with gravel	F I L L	Boring advanced with 4" diameter CFA
				Very stiff, medium brown, highly plastic CLAY FILL with some silt		WC > PL
5	C	10/12	P	Becoming medium to highly plastic		
				Becoming very stiff and mottled with gray		
10	U	18/18	P	Becoming medium plastic		
15	C	8/12	P	Stiff, brown to gray green, medium plastic Silty CLAY FILL with a trace of organic matter		
20	U	0/12	P			
				Stiff, mottled light brown and medium brown, highly plastic CLAY FILL with trace of silt and some low plastic zones		
	U	12/12	P			
25						

WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 23